

The Killing of Mark Duggan

4 August 2011

Report and Methodology
January 2020

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Introduction

Mark Duggan was killed by an officer of the Metropolitan Police Service (MPS) on 4 August 2011, in Tottenham, north London, after armed officers intercepted the vehicle in which he was travelling (a manoeuvre known as a 'hard stop').

The precise nature and sequence of the events that led to Mr Duggan's death have long remained unclear; not least, the question of whether he was holding a gun at the time of his death. Following a coroner's inquest and an investigation by the Independent Police Complaints Commission (IPCC), and an unsuccessful application for judicial review of the coroner's directions to the inquest jury, the Duggan family submitted pleadings for a civil claim in March 2018 (Pamela Duggan & Others v The Commissioner of Police for the Metropolis, Claims No. HQ12X02226 and HQ12X02909).

In the context of that claim, Forensic Architecture (FA) was commissioned by the lawyers for the Duggan family (a team comprised of solicitors and barristers from Bhatt Murphy Solicitors, Birnberg Peirce & Partners, Doughty Street Chambers, and Matrix Chambers) to provide a 3D digital environment as a common framework for those parties involved in the trial, within which the available material and testimonial evidence could be examined by all parties, and the spatial-temporal relations between those pieces of evidence illustrated and analysed.

Following the settlement of that case out-of-court, FA developed this technical-presentational capacity into an investigation based only on materials in the public domain, or otherwise exempt from legal restriction [see [Investigative framework](#)].

Within this digital model, FA interrogated various possible scenarios concerning the open questions surrounding the killing of Mr Duggan, focusing particularly on how the gun that Mr Duggan was allegedly holding at the time of his killing could have arrived at the location at which it was later found.

We first publicly presented our findings to a community meeting in Tottenham, not far from the site of the shooting, on 30 November 2019. Recordings of that presentation can be viewed here:

Introduction: <https://vimeo.com/411322875>

FA's Presentation: <https://vimeo.com/385457988>

Q&A: <https://vimeo.com/412287548>

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About Forensic Architecture

FA is a research agency based at Goldsmiths, University of London. Our team includes architects, scientists, filmmakers, journalists, developers, technologists, and other specialised professionals. The agency undertakes advanced media and spatial research with and on behalf of legal teams, human rights organisations, environmental justice groups, and communities affected by state violence.

We have provided spatial research and evidence for numerous human rights investigations and prosecutions under international law, including [on drone warfare](#) at the UN General Assembly in New York in October 2013 and the Human Rights Council in Geneva in 2014.

We presented evidence in the Israeli High Court in the case of [Battir vs. the Ministry of Defence](#) through Michael Sfar, who won this case on 4 January 2015.

Our report on [the Use of White Phosphorous in Urban Environments](#) was presented at the UN Human Rights Council Geneva in November 2012, and in March 2011 in the Israeli High Court.

Our Forensic Oceanography team (Charles Heller and Lorenzo Pezzani) presented the case of [the Left to Die Boat](#) before the French Tribunal de Grand Instance in April 2012, the Brussels Tribunal de première instance in November 2013, and in the courts of Spain and Italy in June 2013.

[The Gaza Platform](#) and our [Rafah: Black Friday](#) report about the 2014 Gaza War, developed together with Amnesty International, were submitted to the UN Independent Commission of Inquiry in March 2015, and to the International Criminal Court in March and September 2015.

Our [investigation of the murder of Pavlos Fyssas](#) was played before the Court of Appeal of Athens in 2018, as part of the ongoing trial of 69 members of the Golden Dawn political organisation.

Our investigation into [the presence of Russian military units in eastern Ukraine](#) in 2014 was submitted to the European Court of Human Rights in 2019 as part of an ongoing case.

Our analysis of [the land claims of Palestinian Bedouin residents of the village of al-Araqib](#), in Israel's Negev/Naqab desert, is currently submitted to the Regional Court in Be'er Sheva.

More information at www.forensic-architecture.org.

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Investigative framework

The case for which FA was originally commissioned would require the examination of witness statements and transcripts of oral evidence, images, videos, forensic evidence, and expert analysis, including ballistics, biomechanics, and pathology reports.

There is a difficulty in dealing with such a range of forms of evidence: although they refer to the same brief sequence of events, they vary substantially in quality, perspective, and resolution. Digital models, a central component of FA's investigative practice,¹ are a highly effective way to resolve this difficulty, and to synthesise and present multiple forms of evidence.

FA produced an accurate, dynamic 3D model of the scene of Mr Duggan's death, based on contemporary surveys of the site and photographs taken shortly after the incident. This model served as a venue for those various forms of evidence, and as an analytic device, facilitating our interrogation of those sources and of the relationships between them.

How did the gun get to the grass?

We oriented our analysis of those sources, and of the circumstances of Mr Duggan's death, around a central research question. It is understood that there was a gun in the rear of the minicab in which Mr Duggan was travelling: how did that gun travel to the location at which it was later found, seven metres away from the site of the shooting?

The full range of possible answers to the question of '*how did the gun get to the grass?*' are entailed by the following three scenarios:

- 1 Mr Duggan threw the gun during the period of the shots. Specifically:
 1. Before V53 fired the first shot
 2. After V53 fired the first shot
 3. After V53 fired the second shot
- 2 Mr Duggan threw the gun immediately before or during his exit from the minicab.
- 3 Mr Duggan left the gun in the minicab, and it was moved later by MPS officers.

First, we constructed a model of the location of the shooting using architectural modelling techniques, based upon plans, contemporary photographs, and a survey conducted in 2019 by members of the FA team [see [Photogrammetry](#) and '[Model: site, scene, incident](#)'].

Within that digital environment, we modelled, located, and positioned various actors involved in the events surrounding Mr Duggan's death, according to our analysis of witness statements, transcripts of oral evidence, expert reports, and other evidence [see [Analysing witness statements and testimony](#), '[Modelling Mr Duggan](#)', '[V53 and W42](#)', and '[Estimating the Locations of V53 and W42](#)'].

We analysed pathology reports, and forensic, ballistic, and biomechanical evidence to closely reconstruct Mr Duggan's location and body position at the time he was shot, and to examine the question of whether Mr Duggan could have thrown the gun during the period of the shots [see Scenario 1: Mr Duggan threw the gun during the period of the shots], and 'Mr Duggan's injuries, and body position].

We applied independent pathology and biomechanical expertise to our model, to illustrate what such a throw would have looked like [see What would such a throw look like?], and we thereafter recreated scenarios S1a, S1b, and S1c within the model in order to scrutinise the testimony of individual officers [see V53's perspective].

We reconstructed the dynamic moments of the 'hard stop' and compared that reconstruction to witness statements and transcripts of oral evidence, in order to examine scenario S2 [see Scenario 2: Mr Duggan threw the gun before the period of the shots].

We closely analysed the video footage documenting the period of time between the shooting, and the time at which the gun was reportedly found, in order to examine scenario S3 [see Scenario 3: Officers moved the gun after Mr Duggan had been shot] and 'Analysing the 'Witness B footage'], and in doing so identified additional features of that video footage which went unexamined by the imagery analysts commissioned by the IPCC and the inquest [see An unidentified 'gap'].

A full and detailed explanation of the methodologies deployed during this case is left until the final part of this document; the reader is directed toward sections of that methodology during the body of the report.

Source material

Forensic Architecture's investigation relies almost entirely on the documents made public by the 2013 inquest, including materials commissioned by and carried out in the course of the IPCC's investigation. That material includes witness statements, transcripts of oral evidence, photocopies of notes, technical and forensic reports, plans and drawings, photographs, and videos. Additionally, our investigation draws upon two reports commissioned by the lawyers for the Duggan family in the context of the recent civil claim, outlined above. All materials specifically referenced in this report are available here: <https://tinyurl.com/rqenuj3>

The complete set of information made public by the 2013 inquest into Mr Duggan's death is available via the National Archives, here: <https://tinyurl.com/woztrwc>

Named experts

Below, for reference, is a brief introduction to the experts mentioned in the following pages.

Professor Derrick Pounder is a forensic pathologist. He conducted a second post-mortem examination on Mr Duggan's body on 19 August 2011, at the request of Mr Duggan's family. Professor Pounder subsequently provided a detailed statement to the IPCC, and to other experts commissioned by the IPCC, including Professor Clasper.

Professor Colonel Jonathan Clasper is a biomechanical engineering expert and consultant orthopaedic surgeon. It should be noted that Professor Clasper was asked to prepare his report based on the assumption that Mr Duggan was in possession of a gun at the time that he was shot.

Mr David Charles Thorne (Demux Video Services) is an imagery analyst, and a former police officer. He was commissioned by the IPCC to analyse the 'Witness B footage'.²

Mr Clive Richard Burchett (LGC Forensics) is an imagery analyst. He was commissioned to analyse the available video evidence by the Solicitor to the Inquest, Judi Kemish.³

Dr Jeremy Bauer (Bauer Forensics) is a biomechanics expert. He was commissioned by the lawyers for the Mr Duggan family in the context of the 2019 civil claim (No. HQ12X02226).

Previous processes and determinations

Verdict of the 2013 inquest⁴

The jury in the inquest into the death of Mr Duggan delivered its verdict in January 2014. It concluded, in a majority of 9:1, that Mr Duggan threw the gun to the grass. Of those nine, eight concluded that it is more likely than not that Mr Duggan threw the firearm 'as soon as the minicab came to a stop and prior to any officers being on the pavement'.

Of the remaining two, one concluded that Mr Duggan threw the firearm whilst on the pavement, while one was 'not convinced of any supposition' that Mr Duggan threw the gun, since no witnesses gave evidence to this effect.

Additionally, of the ten jurors, eight were 'sure' that Mr Duggan was not holding a gun at the time he was shot. One believed it was more likely than not that he was holding a gun, the other that it was more likely than not that he was not.

Finally, eight of the ten jury members concluded that Mr Duggan was lawfully killed.

Findings of the IPCC report⁵

The IPCC's final report into the killing of Mr Duggan was published in March 2015. It made a total of twenty-four findings. Of those, the following are most notable for the purposes of this document:

1. 'The most plausible explanation for the location of the firearm... is that Mr Duggan was in the process of throwing the firearm... to his right as he was shot.'⁶
2. 'The IPCC is not able to reach a conclusion about the sequence of the two shots.'⁷
3. 'The IPCC investigation has not found material evidence to undermine V53's assertion that he had an honestly held belief... that he saw a firearm in Mr Duggan's right hand.'⁸

Summary of findings

FA's investigation was oriented around the question of *how the gun in question travelled from the rear of the minicab to the location at which it was found, seven metres away*. Concerning that specific question, we have made three findings:

1. **The conclusion of the IPCC regarding the 'most plausible explanation for the location of the firearm' is not consistent with the totality of available evidence.**
 - Mr Duggan could not have thrown the gun to where it was found during the period of the two shots without V53 witnessing the throw.
 - It is practically impossible that Mr Duggan could have been physically capable of throwing the gun after V53's first shot had passed through his bicep.
 - The available evidence is not consistent with V53's assertion that he saw a gun in Mr Duggan's hand (though he may have honestly believed that he saw one).
2. **The available evidence does not rule out the verdict of the inquest jury—that Mr Duggan threw the gun from the threshold of the minicab, before he was shot.**
 - However, for this scenario to be correct, at least the officers W42 and V53 would have to have missed the gun as it crossed their likely field of vision.
3. **The available evidence does not rule out the possibility that officers moved the gun to the location at which it was found, after Mr Duggan was shot.**
 - No justification has yet been given for any investigating authority not to consider this explanation for the gun's location, or to investigate it thoroughly.

We have also made three additional findings:

4. **Concerning the order of the two gunshots, the testimony of V53 was incorrect; he recalled the sequence of the shots in the wrong order.**
 - Contrary to V53's testimony, V53's first shot passed through Mr Duggan's right bicep (not his chest) and struck W42's underarm radio. V53's second shot passed through Mr Duggan's chest (not his bicep) and entered the minicab through the open rear nearside door.
5. **Based on the contents of the 'Witness B footage', the IPCC has no grounds to conclude that the gun was not moved by officers.**
 - Experts commissioned by the inquest, these conclusions were seen by the IPCC, but was not accounted for in the findings of the IPCC's final report.
6. **Imagery analysts separately commissioned by the IPCC and inquest failed to properly investigate video evidence of potential significance.**
 - FA has identified one example of a 'gap' in the footage which was not noticed or investigated by those analysts.
 - The 'gap' in question occurred during a sequence of footage which was viewed repeatedly by the inquest, and as such warranted close examination.

Incident outline

Outlined in this section are known facts or assertions upon which both the IPCC and inquest previously relied, and which FA does not propose to dispute.

- Mr Duggan died at approximately 6:13pm on 4 August 2011, in Ferry Lane, Tottenham,⁹ after the minicab in which he was travelling was stopped by Metropolitan Police Service (MPS) officers in a manoeuvre known as a 'hard stop'.
- As per the image below, following the 'hard stop', the minicab was tightly surrounded by three police vehicles, codenamed Alpha, Bravo, and Charlie.
- Mr Duggan was shot twice by an officer from the MPS' specialist firearms unit, known as CO19. The officer who fired the shots is known as V53. One of the shots fired by V53 struck another CO19 officer, known as W42.¹⁰
- Mr Duggan was known to be in possession of a gun, which was a BBM Bruni 'Mod 92', at the time of the stop. Before the 'hard stop', the gun was in a box on one of the minicab's rear passenger seats.¹¹
- As per the image below, approximately eight minutes after the shooting, the gun was declared found by officers at a location seven metres from the site of the shooting.¹²

The image below, based upon plans and photographs made public by the inquest, presents the 'scene' layer of our model, at the moment that the gun was reportedly found.



Fig. 1. Our modelled reconstruction of the scene of the incident, including three police vehicles, the minicab in which Mr Duggan was travelling, and the location at which the gun was found [see [Methodology: Model](#)].

Building the incident

Mr Duggan's injuries, and body position

Mr Duggan was 178cm tall.¹³ We modelled his body based on images and information from pathology reports by Dr Poole and Professor Pounder^{14,15} [see [Modelling Mr Duggan's body](#)]. Those reports and images are in agreement that one bullet passed through Mr Duggan's right bicep, also causing damage to the right hand side of his chest wall, while another passed through his torso, entering in the upper right hand side of his chest, and exiting through the lower left hand side of his back.¹⁶

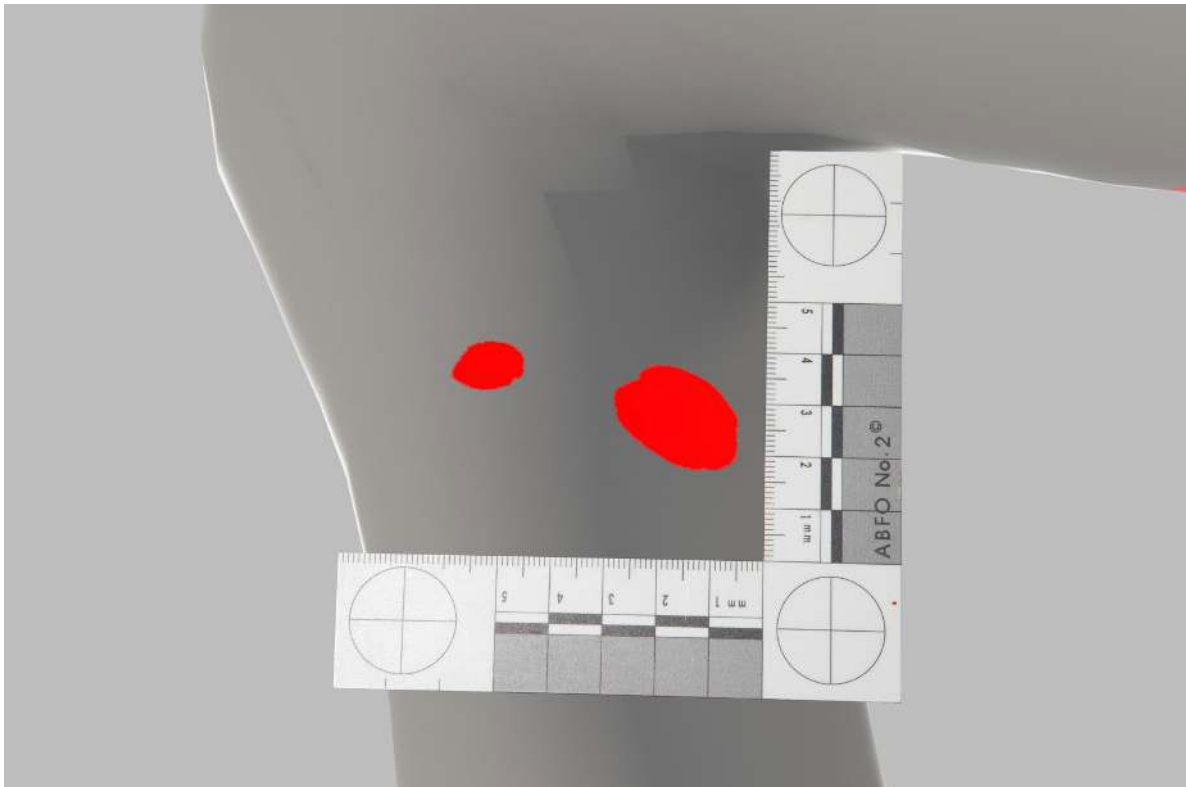
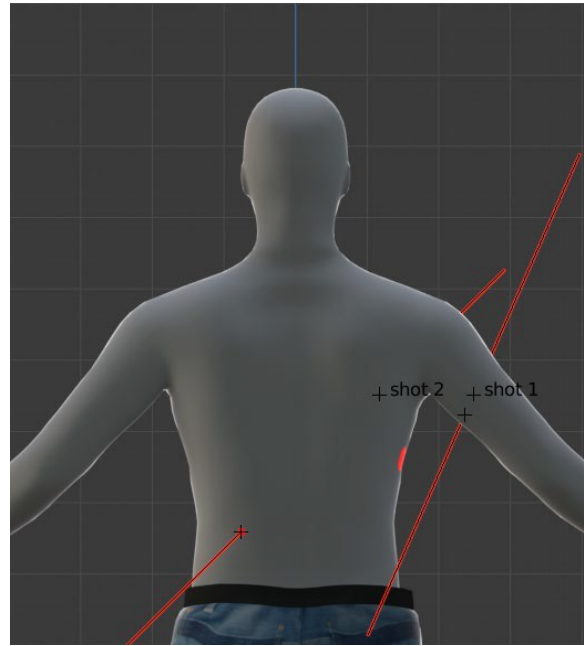
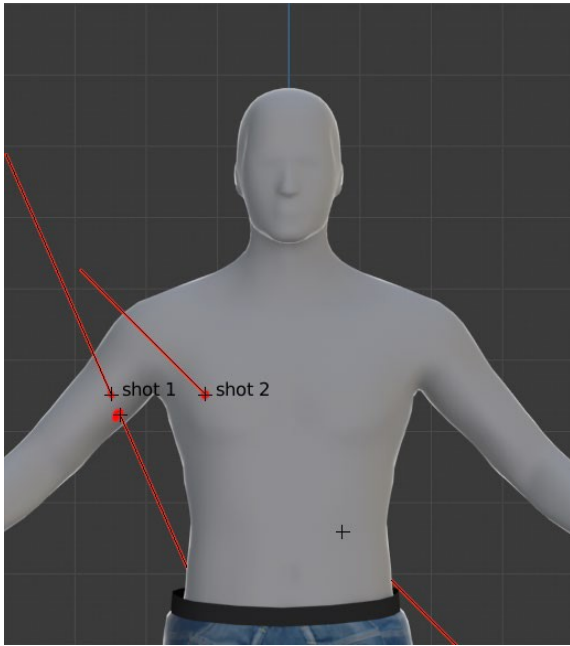


Fig. 2. A redacted post-mortem photograph overlaid onto our model of Mr Duggan, to locate entry and exit wounds on Mr Duggan's right bicep.

Lines drawn between each entry and exit wound pair, and extrapolated beyond the body, describe the direction of travel of each bullet in relation to Mr Duggan's body.



Figs. 3 and 4. Front and rear view of our model of Mr Duggan, with lines drawn between entry and exit wounds.

These 'shot lines' give us an indication of Mr Duggan's body position at the time of each of the shots, as well as information about the locations of officers V53 and W42 relative to Mr Duggan at the time of the first shot [see [Locations of Mr Duggan, V53, and W42](#)].



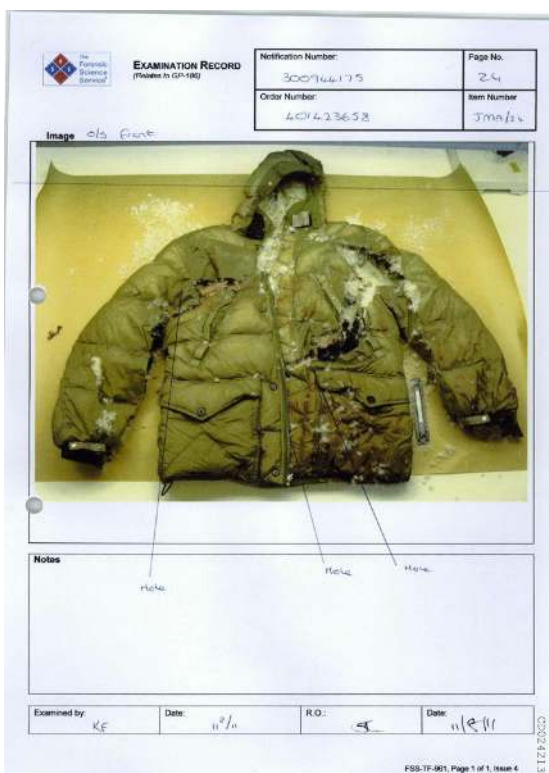
Fig. 5. Our model of Mr Duggan could be 'posed', such that the 'shot lines' correspond to known facts about the height and position of V53 and W42, and of the rear nearside door of the minicab.

Damage to Mr Duggan's jacket

On 4 August 2011, Mr Duggan was wearing a green 'puffa' jacket. Two holes, were identified in the front left corner pocket area of Mr Duggan's jacket, caused by a bullet.¹⁷ One of those holes had been caused by a bullet penetrating from the inside of the jacket to the outside, and the other from outside to inside.¹⁸

This damage suggests that as Mr Duggan emerged from the minicab, his left hand was either inside the pocket of his jacket, or was holding his jacket, and was held across his chest in such a way that the jacket was in the path of the second shot, which penetrated his chest [see Sequence of the two shots].

According to the opinion of Professor Pounder and the testimony of officers V53 and W70, Mr Duggan's right hand was across his waist at the time of the first shot.¹⁹



Figs. 6 and 7. Mr Duggan's jacket following the shooting (right), and modelled, showing the approximate position of his left arm at the time of the second shot, according to the damage to the jacket's lower left front pocket area.

V53 and W42

Two officers were directly involved in the shooting of Mr Duggan: V53 fired the two shots; W42 was struck by one of those shots. The shot hit W42's radio, carried in an under-arm holster.^{20,21} The height of each officer, and the position of the radio, gives us more information about the relative positions of Mr Duggan and the officers during the period of the shooting.

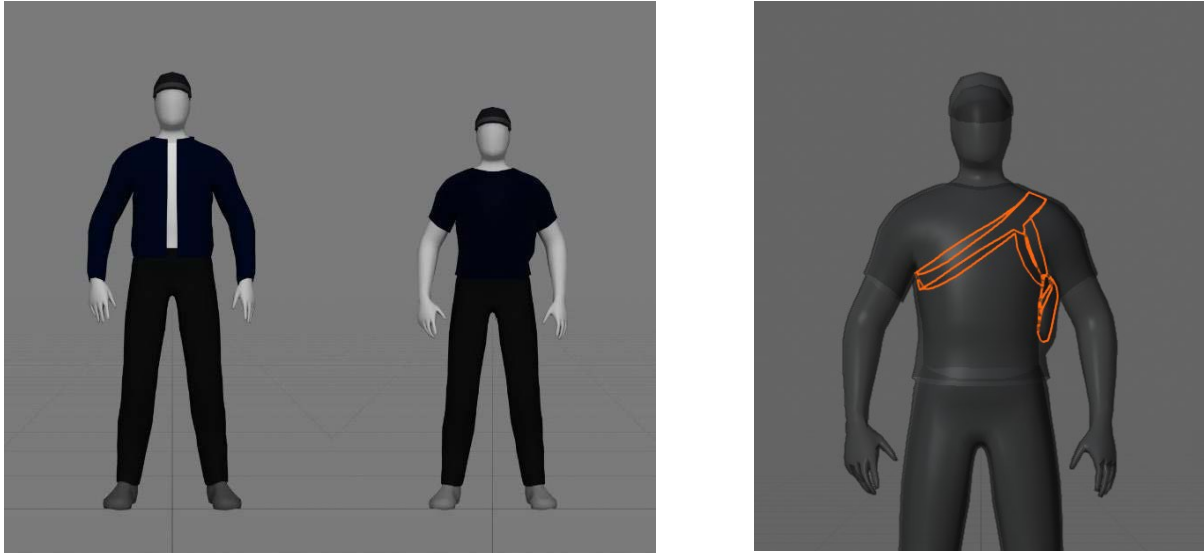
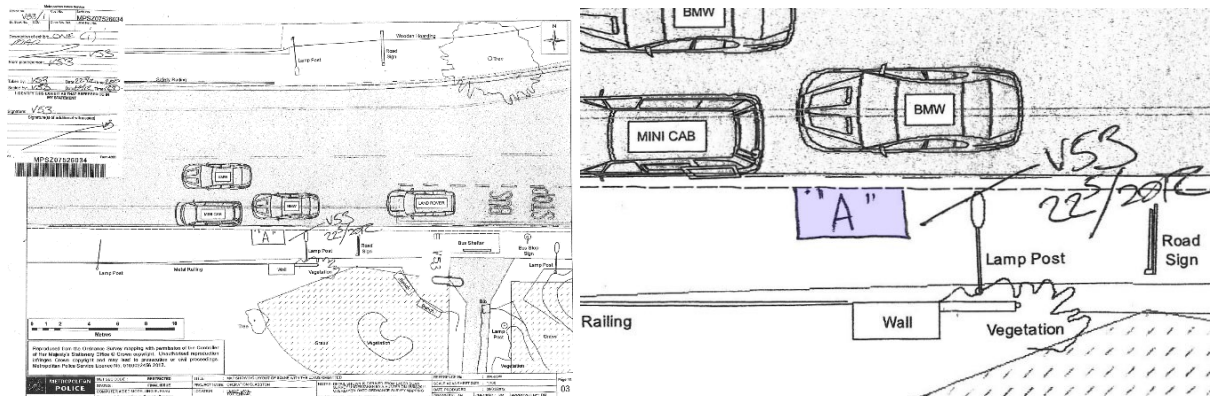


Fig. 8 and 9. V53 and W42; W42 with under-arm radio holster highlighted.

The height of V53 and W42 is approximated from evidence given to the inquest.^{22,23} V53 is approximated to 188cm (6ft 2in) and W42 is 171.45cm (the average of 5ft 7in and 5ft 8in). W42's underarm radio was approximately 110cm from the ground. We modelled the underarm radio holster that W42 was wearing based on Professor Seaman's report and the transcript of W42's evidence.²⁴

Locations of Mr Duggan, V53, and W42

The officers present at the shooting were asked to describe, using plan views, approximately where V53 and W42 were located at the time of the shooting. An example is below.



Figs. 10 and 11: Plan drawn by V53; detail of plan with indicated area highlighted

By cross-referencing those plans with one another, with testimony, and with physical facts about the scene [see [Methodology: Locations of V53 and W42](#)], we arrived at the following regions within which V53 and W42 were likely stood at the time of the shots.

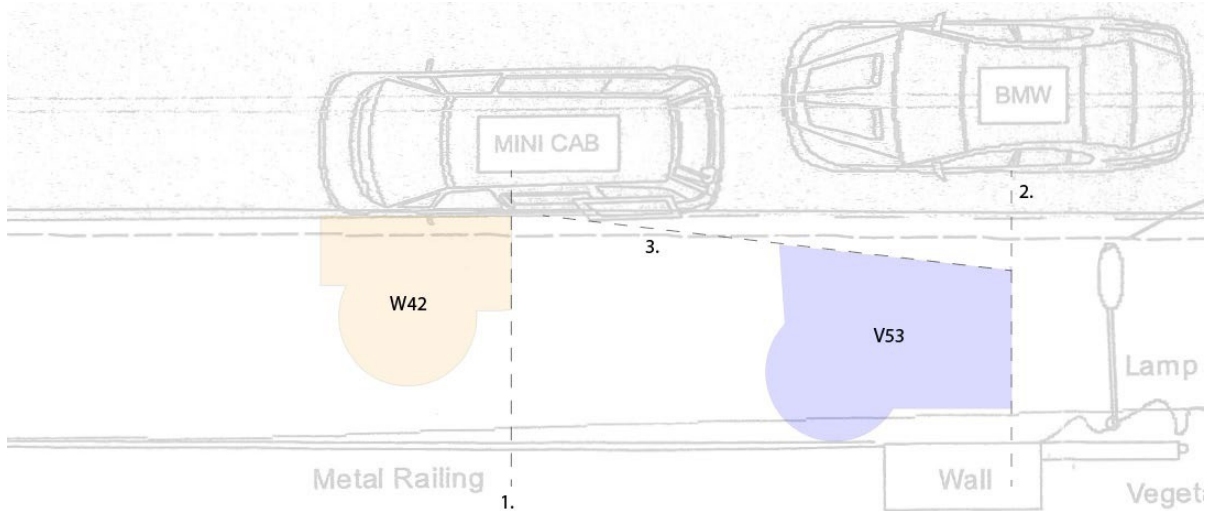


Fig. 12. Our analysis of plans drawn by the officers who witnessed the incident resulted in two regions in which W42 and V53 were likely to have been standing at the time of the shots. Three further constraints are indicated, which are explained in [Methodology: Estimating the locations of V53 and W42](#).

Inserted into our site model, these regions constitute the first constraints on the likely, and indeed possible, locations of the officers V53 and W42, and Mr Duggan.

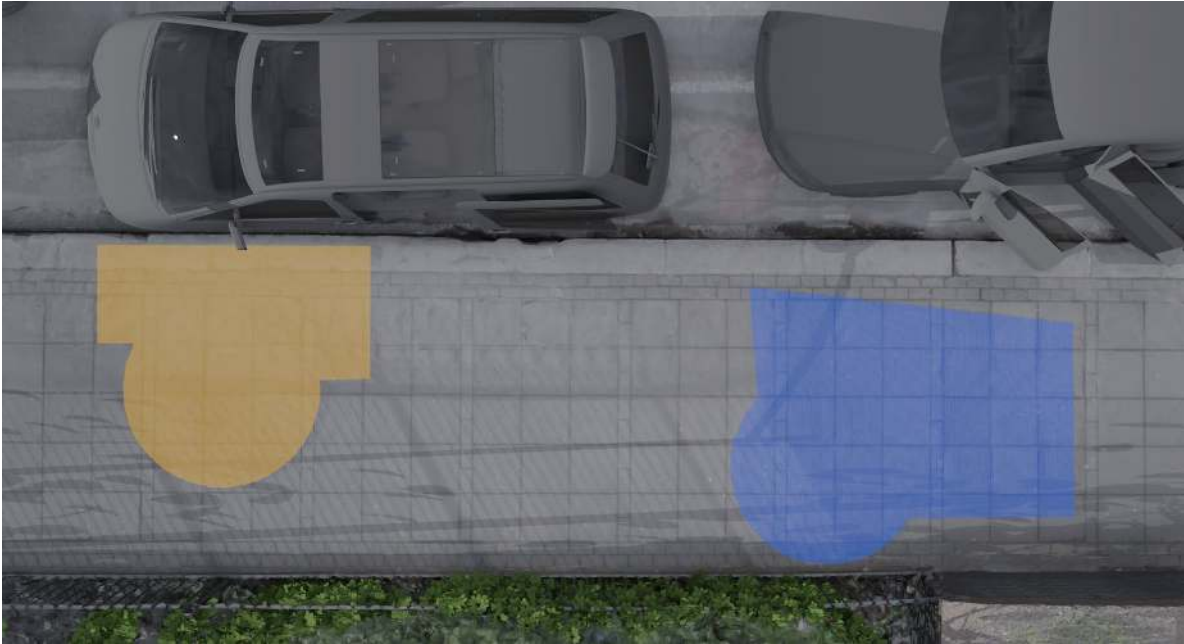


Fig. 13. The areas indicated by the officers are transposed into our model.

To locate Mr Duggan at the time of the first and second shots, we referred to the 2019 report prepared by Professor Pounder, who determined that Mr Duggan began to move away from the minicab at an angle of 22 degrees, in the approximate direction of V53, leading with his right foot.²⁵ Together, these conclusions and the ‘shot lines’ that were determined by reference to Dr Poole’s conclusions [see [Entry and exit wounds](#)] act as constraints on the spatial relationships between:

1. Mr Duggan, V53, and W42 at the time of the first shot, and
2. Mr Duggan, V53, and the minicab at the time of the second shot.

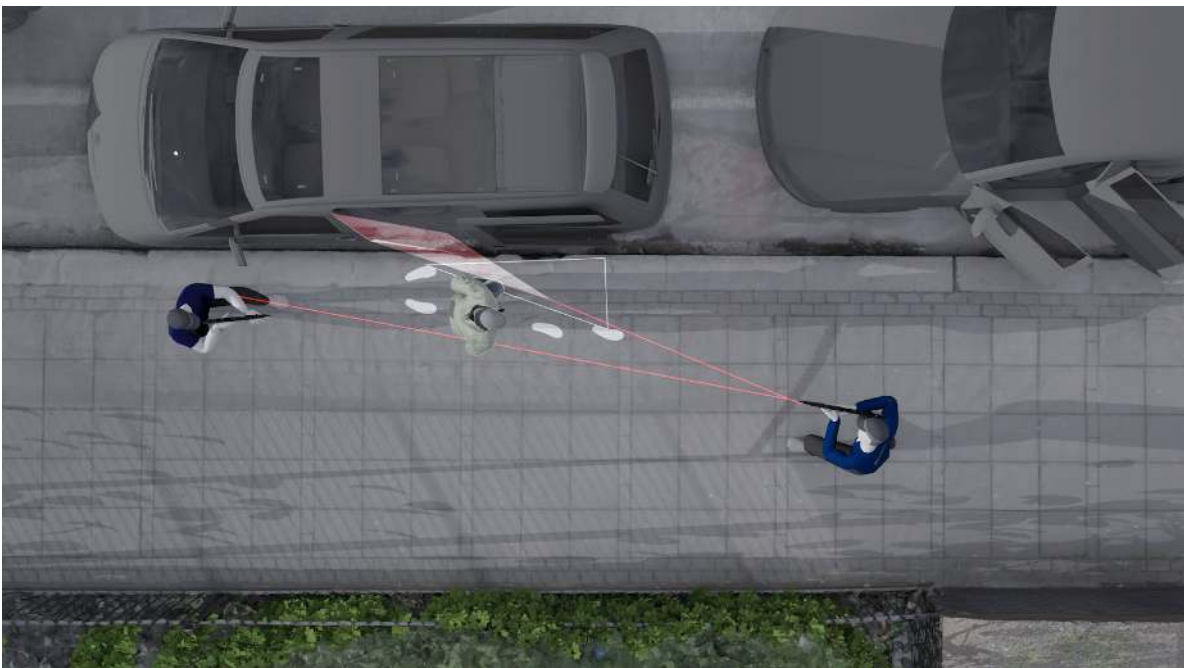


Fig. 14. Plan view of the body position of Mr Duggan as he received the second gunshot, constrained by a ‘shot line’ which goes through the door of the minicab, and the determinations of Professor Pounder’s 2019 report.

As the image below demonstrates, the spatial constraints determined by reference to the conclusions of Professor Pounder and Dr Poole are mutually compatible with those determined by reference to the plans drawn by the officers.

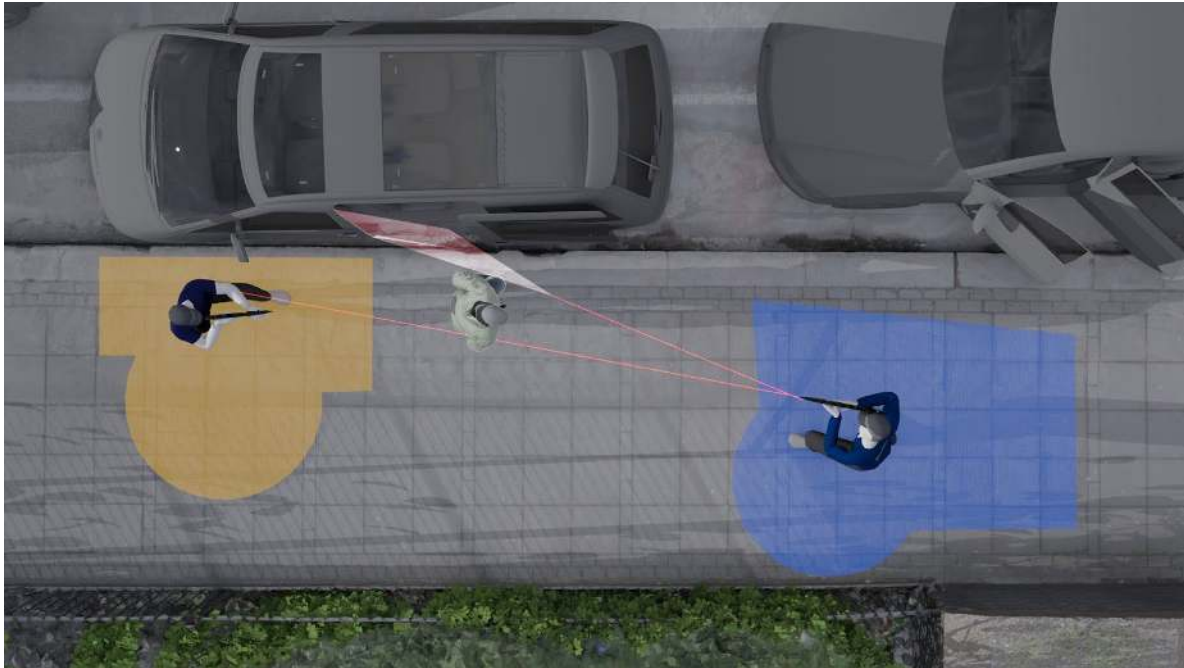


Fig. 15. Within our model, possible relative positions of Mr Duggan, W42, and V53 are constrained with reference to the analysis of plans drawn by the officers who witnessed the incident, and the analysis of Professor Pounder.

Sequence of the two shots

The IPCC concluded that it was not possible to determine the sequence of the two shots fired by V53; that is, whether W42 was hit by V53's first or second shot.²⁶ (Ballistic evidence excludes the possibility that the bullet which passed through Mr Duggan's chest was the bullet which struck W42's radio.²⁷ The question under consideration, then, is whether V53's first or second shot passed through Mr Duggan's bicep, and struck W42's radio.)

V53 told the inquest that his first shot penetrated Mr Duggan's chest.²⁸ W42 told the inquest that 'I heard the first shot and my body told me I then felt pain'.²⁹ The IPCC report suggests that W42's evidence is 'open to question', but it does not make the same claim about V53's evidence.³⁰

The IPCC report suggests that Professor Pounder's account, which concludes that V53's first shot passed through Mr Duggan's bicep, 'placed heavy reliance on W42's account in reaching his conclusion regarding the order of the shots'.³¹ However, Professor Pounder in fact states that sequence of shots he proposes is the only one which corresponds 'satisfactorily' and 'in general'³² to the available information and testimony concerning the incident. Indeed, even V53's own account describes Mr Duggan's right shoulder moving backward in a sharp 'flinching movement' after the first shot.³³

The movements required for V53's first shot to have passed through Mr Duggan's chest are inconsistent with the description of his movements given by W39 and W70.³⁴ Mr Duggan would have had to bend forward significantly in order to receive the (lethal) chest shot, before rapidly rising to an upright position in time to receive the shot to his right bicep.

For the purposes of our analysis, then, we have followed the assessment of Professor Pounder who concluded that the scenario in which W42 was hit by V53's first bullet is much more consistent with the totality of other evidence and testimony.

FINDING 1

Our analysis, taking into account the conclusions of Professor Pounder, suggests that V53's first shot passed through Mr Duggan's right bicep and struck W42's underarm radio. V53's second shot passed through Mr Duggan's chest and entered the minicab through the open rear nearside door.

According to our analysis, V53's testimony is inconsistent with the available physical evidence and witness testimony.

According to our own analysis and the analysis of expert evidence seen by the IPCC, W42's account of the sequence of the shots is more consistent than that of V53 with the totality of other evidence and testimony.

Scenario 1: Mr Duggan threw the gun during the period of the shots

This is the conclusion that was arrived at by the IPCC: ‘the most plausible explanation for the location of the gun is that Mr Duggan was in the process of throwing the gun as he was shot’.³⁵ Indeed, the IPCC report states that ‘the only apparent mechanism for the firearm to have been brought out of the shoebox and onto Ferry Lane was by Mr Duggan getting out of the minicab with the firearm in his possession.’³⁶

In order to examine this scenario, we first assess what is known about the locations of Mr Duggan, V53, and W42. Then, we assess the physical movement that would have been required to throw the gun to the location at which it was found. Finally, we assess the possibility that V53 could have failed to see this movement.

The two shots

Note: *in the following four images (Figs. 16-19) Mr Duggan is shown without a gun in his hand. At this stage, this is not a determination; these images present a likely spatial relationship between Mr Duggan, V53, W42, and the minicab during the period of the shots, rather than the question of whether or not Mr Duggan was holding a gun during that period. The body posture of Mr Duggan in these images is derived from Professor Pounder’s 2019 report.³⁷*

The first shot

The first shot travelled through Mr Duggan’s right bicep and hit W42 in his radio below his left armpit. A range of possible positions for Mr Duggan could theoretically be inferred from this line; the position described in the image below accords with the assessment of Mr Duggan’s movements proposed by Professor Pounder.³⁸



Fig. 16. Aerial view of shot one.

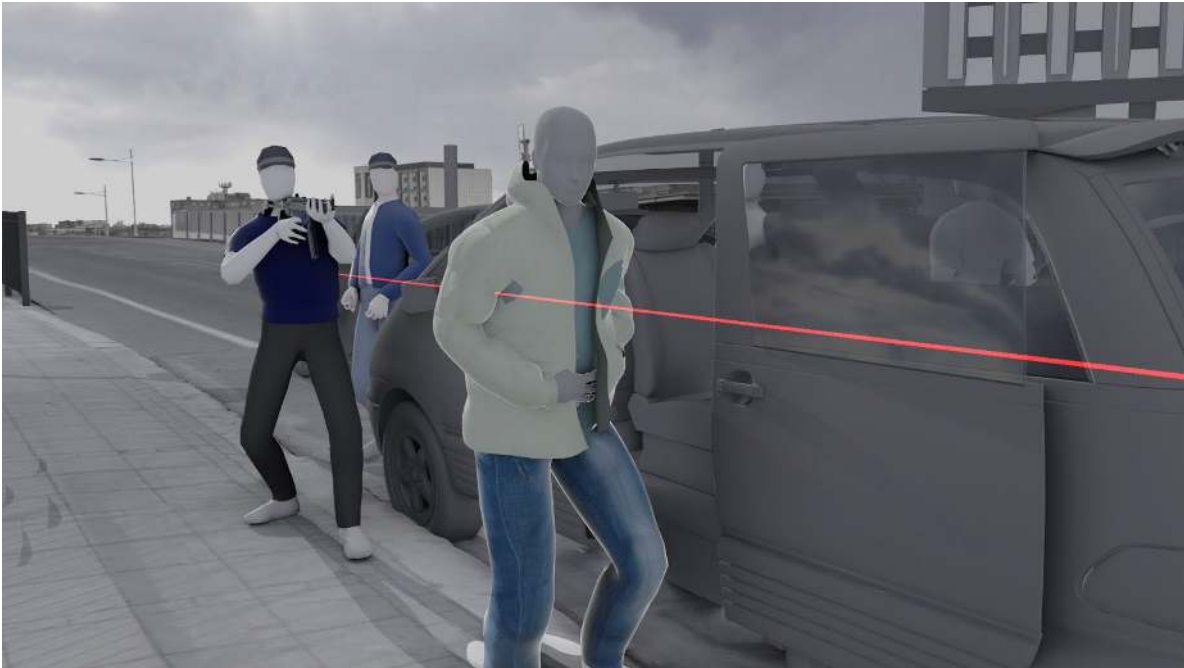


Fig. 17. Ground level view of shot one.

The second shot

The second shot travelled through Mr Duggan's chest and entered the minicab through the open rear nearside door. The bullet was recovered from a plastic bag on the floor of the vehicle. Again, a range of possible positions for Mr Duggan could theoretically be inferred from this line; the position described in the image below accords with the assessment of Mr Duggan's movements proposed by Professor Pounder.³⁹



Fig. 18. Aerial view of shot two.



Fig. 19. Ground level view of shot two.

Throwing the gun

What would such a throw look like?

The gun was found approximately seven metres from where Mr Duggan was standing at the time of the first shot.^{40,41} The weight of the gun is 1050g.⁴² For the gun to reach the location at which it was found, Mr Duggan would have had to throw the gun at a minimum speed of 6.7m/s, at an angle between 31 and 40 degrees.⁴³ Such a throw would have required a 'large sweeping motion of his arm'.⁴⁴



Fig. 20. The distance from the location at which Mr Duggan was shot to the location at which the gun was found.



Fig. 21. Close view of Mr Duggan, demonstrating the (approximate) required angle of throw.

V53's perspective

In finding that 'the most plausible explanation for the location of the gun is that Mr Duggan was in the process of throwing the gun as he was shot',⁴⁵ the IPCC relied upon the testimony of both V53 and W70 that Mr Duggan was holding a gun at the time of the first shot.⁴⁶

According to our analysis, V53 was standing between three and four metres away from Mr Duggan at the time of the first shot. The sun would not set for a further two and a half hours after the shooting,⁴⁷ and by his own admission V53's view was unobstructed,⁴⁸ sufficient for him to describe the gun in detail.⁴⁹

Given the known (approximate) positions of Mr Duggan, V53, and W42 during the period of the shots, we can recreate the perspective of V53 during that period. However, V53 also testified that he did not see Mr Duggan make any kind of throwing motion.⁵⁰

The following two images approximate V53's perspective immediately before and at the time of the first shot.

Note: as above, in the following two images Mr Duggan is shown without a gun in his right hand. At this stage, this is not a determination; these images present the approximate perspective that V53 would have had of Mr Duggan, regardless of whether Mr Duggan was in fact holding a gun at that time. The body posture of Mr Duggan is derived from Professor Pounder's 2019 report.⁵¹



Fig. 22. A simulation of V53's view of Mr Duggan as he exited the minicab.



Fig. 23. A simulation of V53's view of Mr Duggan at the time of the first shot.

The throw

Based on the information above, we reconstructed V53's approximate perspective during the period of the shots, according to the following three scenarios:

- a. Mr Duggan throws the gun immediately before V53's first shot,
- b. Mr Duggan throws the gun between V53's first and second shots, and
- c. Mr Duggan throws the gun after V53's second shot.



Fig. 24. A still from our reconstruction of V53's approximate perspective during the period of the shots, if Mr Duggan had thrown the gun before V53's first shot (Scenario S1a).



Fig. 25. A still from our reconstruction of V53's approximate perspective during the period of the shots, if Mr Duggan had thrown the gun between V53's first and second shot (Scenario S1b).



Fig. 26. A still from our reconstruction of V53's approximate perspective during the period of the shots, if Mr Duggan had thrown the gun after V53's second shot (Scenario S1c).

We also reconstructed V53's approximate perspective during the period of the shots according to the additional scenario:

- d. Mr Duggan exits the minicab without a gun in his hand.

Note: a short video clip of these scenarios can be viewed here: <https://tinyurl.com/tw5j6zy>

Professor Pounder concluded: 'I cannot conceive of how Mr Duggan might have thrown the gun to the place it was found, unobserved by the police.'⁵² Dr Bauer concluded similarly, that the required throwing motion 'would be readily observable by people both in front of, or behind Mr Duggan.'⁵³

However, the IPCC report stated that: 'It has not been possible to determine why V53 did not see what happened to the firearm immediately after he fired the two shots, although this does not undermine V53's account.'⁵⁴

Pathology evidence

Professor Pounder concluded in his 2019 report that 'given the nature of the two gunshot injuries... I cannot conceive of how MD could have thrown the Bruni gun forwards and to his right in an arc over fencing to where it is said to have been found, 7-8m away, using what would need to be an extended underarm throw.'⁵⁵

Following his examination of the existing pathology evidence, Dr Bauer concluded that 'the trauma to the inside of Mr. Duggan's right arm likely would have caused Mr. Duggan to drop the gun before he could toss it.'⁵⁶

Further, Dr Bauer concluded that 'it was unlikely Mr. Duggan could have thrown the gun after he was shot in the arm. Instead, had he been holding a gun when he was shot, he likely would have dropped the gun where he was shot.'⁵⁷

FINDING 2

The conclusion of the IPCC regarding the 'most plausible explanation for the location of the firearm' is not consistent with the totality of other evidence. The available evidence is not consistent with V53's assertion that he saw a gun in Mr Duggan's hand (though he may have honestly believed that he saw one).

The available physical evidence raises substantial problems for the IPCC's conclusion, which are not accounted for. These problems were highlighted at the time, and have been raised again in subsequent reports, such as that of Dr Bauer. The IPCC's conclusion does not satisfactorily resolve (or engage with) two contradictory premises:

- 1. V53 was, by his own admission, focusing specifically on Mr Duggan's hands.*
- 2. V53 did not witness anything like the significant physical motion required for Mr Duggan to throw the gun to the location in which the gun was found.*

In fact, of the three possible answers to the question 'how did the gun get to the grass?', the conclusion of the IPCC is the answer least supported by the available evidence.

Scenario 2: Mr Duggan threw the gun before the period of the shots

This conclusion was arrived at by the jury at the coroner's inquest. Eight of the ten jury members concluded that Mr Duggan threw the gun to the location at which it was found 'as soon as the minicab came to a stop'.

This scenario is possible and is not ruled out by the available evidence. However, for it to be correct, at least two officers would have to have missed the gun as it moved across their field of vision—including W42, who gave evidence to the inquest to the effect that he could not have missed the gun, had it been thrown.⁵⁸ In order to demonstrate this, we first recreated the sequence of the 'hard stop'. Then, we viewed our reconstruction of the 'hard stop', and the moments after the minicab comes to a stop, from the perspective of three officers.

CO19 training video

On 6 November 2013, the inquest was shown a video, which shows how CO19 officers carry out the 'hard stop' manoeuvre on a moving vehicle.⁵⁹

A number of the officers described the stop on 4 August 2011 as a 'textbook' example of a 'hard stop', up until the point at which the minicab came to a halt.⁶⁰ As such, we animated the 'hard stop' within our model using the timings in the training video shown to the inquest.

A composite of the original training video alongside our animated reconstruction can be viewed at the following URL: <https://tinyurl.com/wjzfzzk>



Figs. 27 and 28. Side-by-side stills from the CO19 training video and our animated reconstruction, at two moments during the 'hard stop'.

Officers' perspectives

Note: Our analysis here addresses questions of perceptibility over time. As such, the best way to engage with our analysis of each officer's perspective is by watching the short video clips at the URLs given below. The screenshots in the following sections are drawn from those short video clips.

In order to assess whether any of the officers could have seen the gun, had it been thrown by Mr Duggan from the threshold of the minicab as he exited, we closely reconstructed and animated the timings of the 'hard stop' [see CO19 training video] and 'Adjusting timings from the CO19 training video', and viewed the scene from the perspective of three officers who, according to our analysis, could have been in a position to see the gun, had it been thrown as Mr Duggan was exiting the minicab: W42, W56, and V53.

Note: Short video clips approximating the perspective of the officers W42, W56, and V53 during the period of the 'hard stop' can be viewed here: <https://tinyurl.com/sejo799>

W42's perspective

At the inquest, W42 was posed the following statement: 'There is no way Mr Duggan could have thrown the gun from the minicab and me not see it'. Asked if this was his evidence, W42 confirmed that it was.⁶¹ He also stated that he 'had vision on the vehicle at all times' during the moments that the minicab came to a stop,⁶² and twice disagreed with the suggestion that he would have failed to notice if Mr Duggan had thrown the gun from the minicab.⁶³

W42 told the inquest that as he exited the Alpha vehicle, he first looked at the minicab driver, before moving towards the front nearside of the vehicle.⁶⁴



Fig. 29. A still from our approximation of W42's perspective as he exited Alpha vehicle, assuming Mr Duggan was throwing the gun at this time.

W56's perspective

W56 was travelling in the rear of Alpha at the time of the 'hard stop'.⁶⁵ W56 told the inquest that he could see the minicab driver looking over his left shoulder, in the direction of the rear nearside door.⁶⁶ W56 also told the inquest that he could not see Mr Duggan, but that he was looking in the direction of the rear nearside door, on the opposite side of the minicab.⁶⁷

Note: W56's evidence does not specify whether he exited Alpha from the rear nearside or outside door. Thus, we have approximated his movements by reference to the training video.



Fig. 30. A still from our approximation of W56's perspective as he exited Alpha vehicle assuming Mr Duggan was throwing the gun at this time.

V53's perspective

V53 was travelling in the front passenger seat of Charlie car.⁶⁸ In his evidence to the inquest, V53 describes watching the rear nearside door of the minicab slide open, and Mr Duggan exiting the vehicle,⁶⁹ suggesting that V53's visual attention was focused on the region through which the gun would have travelled, during the period that it would have been thrown, if Mr Duggan had thrown it immediately before or as he exited the minicab.



Fig. 31. A still from our approximation of V53's perspective as he exited Charlie vehicle, assuming Mr Duggan was throwing the gun at this time.

FINDING 3

The conclusion arrived at by the inquest jury is not ruled out by the available evidence. However, for this scenario to be correct, W42 and V53 would have to have missed the gun as it crossed their field of vision.

According to their own testimony, the focus of at least two officers' (W42 and V53) visual attention would have been directed toward precisely the area that the gun would have passed through as it was thrown from the threshold of the rear nearside passenger door of the minicab.

It is, of course, possible that the officers simply missed the gun as it passed through their field of vision, and it should be noted that the inquest's verdict remains more consistent with the totality of other evidence and testimony than the conclusion of the IPCC.

Scenario 3: Officers moved the gun after Mr Duggan had been shot

This scenario was not adequately considered by the IPCC. While it was addressed at the inquest during the questioning of a number of officers, certain technical capacities which would have enabled more effective interrogation of the available video evidence, and by extension of the officers seen in that video evidence, were not correctly or properly taken up.

The IPCC report asserts that this scenario can be discounted due to a lack of evidence. In order to examine this claim, we will first assess the limitations of the video evidence in question (referred to as either ‘Witness B footage’ or ‘BBC footage’) and describe some of the actions we undertook to mitigate for those limitations. Then, we will show that certain areas of the site were hidden from the perspective of ‘Witness B’.

Finally, we will show that it is at least possible that the officers present could have moved the gun to the location at which it was found, by proposing one hypothetical scenario.

The ‘Witness B footage’

A member of the public filmed the events following the shooting.⁷⁰ That individual came to be known as ‘Witness B’ for the purposes of the IPCC’s investigation, and the inquest. Witness B filmed six separate videos, covering a period of approximately fifteen minutes,⁷¹ and beginning around 40 seconds after the minicab came to a stop.⁷² Witness B filmed the scene from a high-rise residential building immediately north of Ferry Lane.

Note: we deployed a handful of media-analytic techniques to interrogate the footage. These are extensively described and detailed in [‘Methodology: Analysing the ‘Witness B footage’](#).



Fig. 32. A still from the Witness B footage.

The IPCC's assessment

The possibility that the gun was moved by officers after the shooting appears to have been discounted by the IPCC without serious consideration.⁷³ The IPCC report stated: 'There is... no sign of any officer planting a firearm on the grass during the "BBC Footage"'.⁷⁴ It also stated that: 'there is no evidence any person entered the rear of the minicab between the shooting and the point at which [officer] R31 found the firearm'.⁷⁵

However, the report also cites LGC Forensics' Clive Burchett, who states that he 'could not eliminate the possibility that the weapon was present' in (i.e. within the frame of) the footage. In his evidence to the inquest, Burchett restated that his conclusion is not that the gun was not present in the footage, but that the image quality was too poor for it to be seen.⁷⁶

Limitations of the footage

Note: A video clip of this analysis can be viewed here: <https://tinyurl.com/uah2w9a>

In order to examine the claim that the footage 'shows no sign of an officer planting the firearm', we recreated how the gun would appear in the original resolution of the footage.

First, we select part of the image frame near the minicab, and zoom into it.



Figs. 33 and 34. A close-up view (right) of a small area of the full image frame (left).

Then, we model that part of the frame, and add to it an accurately scaled model of the gun.



Figs. 35 and 36. A model of the gun is added to our site model. In high resolution, it is clearly visible.

Then we re-apply the effects of blur and other image degradation. As a result, in the left-hand image below, the gun is clearly not discernable.



Figs. 37 and 38. Left, image degradations are applied to our model. Right, for comparison, the original close-up from the footage.

Our analysis confirms Burchett's assessment that if the gun *were* in the video frame, it would not be visible due to the quality of the footage. This implies that even if officers had carried the gun to the location at which it was found, this would not have been visible in the footage.

Therefore, it is not accurate to say that 'there is no sign of any officer planting the firearm on the grass'; the IPCC's assessment to this effect is an incorrect interpretation of the evidence. Rather, the footage is not able to act as evidence either way, with respect to that claim.

Entering the rear of the minicab

The second claim made by the IPCC and noted above, that 'there is no evidence any person entered the rear of the minicab',⁷⁷ is a similarly incorrect interpretation of the evidence.

'Blind spots'

The position from which Witness B is filming creates 'blind spots' on the opposite side of each of the vehicles on the site. The following image shows those blind spots, in hatching; the area immediately south of the minicab and Charlie vehicle is highlighted in red.

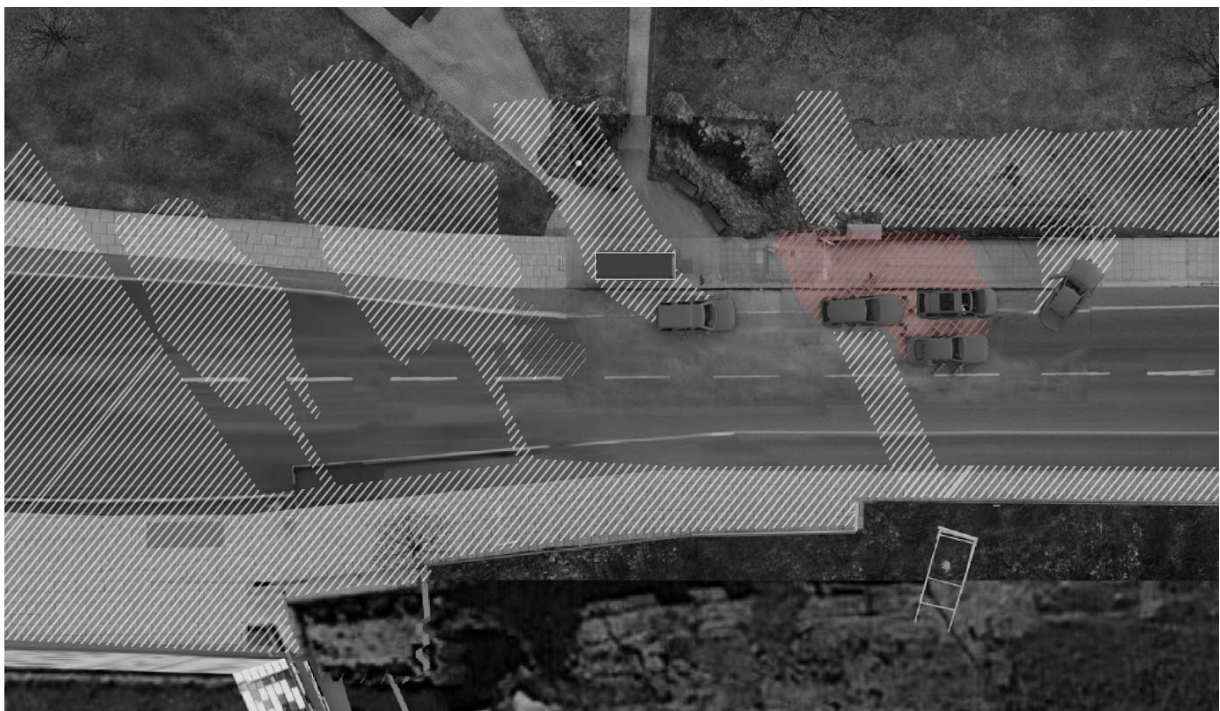


Fig. 39. A plan view of the 'blind spots' from Witness B's position. Blind spots are indicated by hatched areas.

Any officer entering the hatched blind spots during the period of the footage would not be visible to the camera. Importantly, any officer who entered the *red* hatched area could have entered the rear of the minicab without this action being visible in the footage.

Timeline

The following image is a timeline of the first eight minutes of the footage. (The gun was found by either R31 or Z51 sometime shortly after 07m28s in the footage.)⁷⁸ Time is on the x axis. Each row on the y axis represents an officer seen in the footage.

Within the timeline, multiple lines could, and likely do, refer to the same officer, but in light of the challenges posed by the ‘blind spots’ and general poor image quality, we have not assumed that two individuals seen at different times are the same person unless we can be absolutely certain.⁷⁹ Within each row, white and grey lines indicate periods of time during which an officer is either partially or completely hidden from view in a ‘blind spot’ [see Analysing the ‘Witness B footage’].

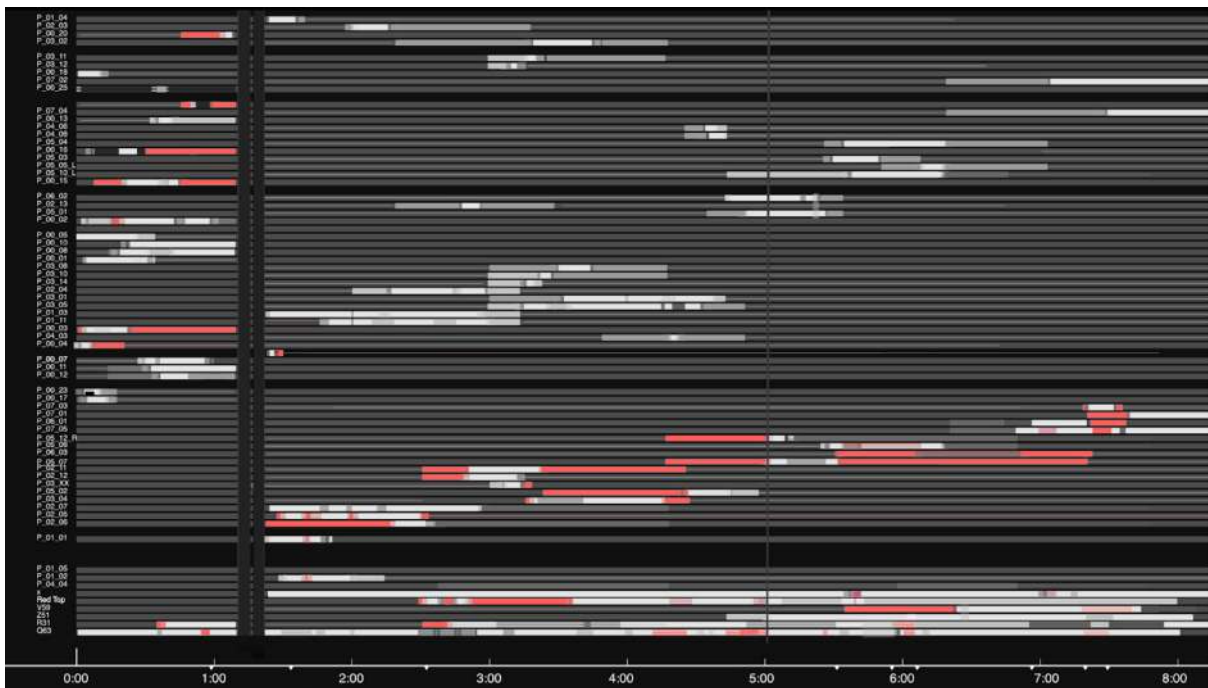


Fig. 40. A timeline indicating when officers were partially or completely hidden from Witness B's perspective.

Note: the timeline above can be viewed in full here: <https://tinyurl.com/tym3hw6>

Each red line corresponds to a period of time during which one officer is hidden from view in the area south of the minicab and Charlie vehicle.

We identified around a dozen such periods; in each of these cases, the officer in question could have entered the rear of the minicab without this action being visible in the footage.

As such, the claim that ‘there is no evidence any person entered the rear of the minicab’,⁸⁰ is also an incorrect interpretation of the evidence. Rather, there are periods of time during which officers could have entered the minicab, and the footage does not exclude this possibility.

In the section that follows, we will examine the possibility that one of those periods could have led to the planting of the firearm, by proposing one hypothetical scenario, consistent with the evidence presented in the footage.

FINDING 4

Based on the contents of the 'Witness B footage', the IPCC has no grounds to conclude that the gun was not moved by officers. Moreover, the IPCC was aware of expert evidence to that effect.

Our analysis does not show that officers moved the gun from the minicab to the location at which it was found. It does, however, show that the IPCC cannot rule out such a possibility based on the contents of the footage.

The IPCC's conclusion is an incorrect interpretation of the report by LGC Forensics' Clive Burchett, who explicitly concludes that he 'cannot eliminate the possibility' that the weapon is in the frame of the footage, but not visible due to limitations of the footage.

A possible route from the minicab to the grass

Note: what follows in this section is the discussion of one possible (hypothetical) scenario by which a handful of officers could have conveyed the gun from the rear passenger seat of the minicab to the location at which it was found, according to their known movements in the Witness B footage. Nothing in the footage suggests that this is in fact what happened. We present this scenario in order to demonstrate that it is possible, and that no evidence yet discounts it.

A video clip illustrating this scenario can be viewed here: <https://tinyurl.com/un4ajtr>

This scenario is also explained in depth in our full video investigation, and in the video of our 30 November 2019 presentation, URLs for which can be found at the top of this report.

The gun was recovered sometime shortly after 07m28s in the footage.⁸¹ At that time, officers R31 and Z51 were stood on the grass, near the location at which the gun was found.



Fig. 41. A still from our analysis. Evidence of image stabilisation can be seen at the edges of the image, and figures are labelled and 'tracked'. This is the first second of the short period in which the gun was likely reported found.

For the purposes of this hypothetical scenario, our analysis proceeded as if, around this time, R31 was in possession of the gun, and proceeded to drop it at the location indicated by Z51 in the following photograph, taken by a member of the public.



Fig. 42. A photograph taken by a member of the public shows officer Z51 pointing at the location at which the gun was found. According to our analysis, this occurs at 07m28s [see [Analysing the 'Witness B footage'](#)].

Around two minutes earlier, R31 can be seen in the footage meeting another officer, Q63, on the pavement near the minicab. The following images depict this moment, in the footage and in our model.



Fig. 43. 05m54s into the footage, R31 and Q63 are visible by the fence, next to Alpha vehicle.

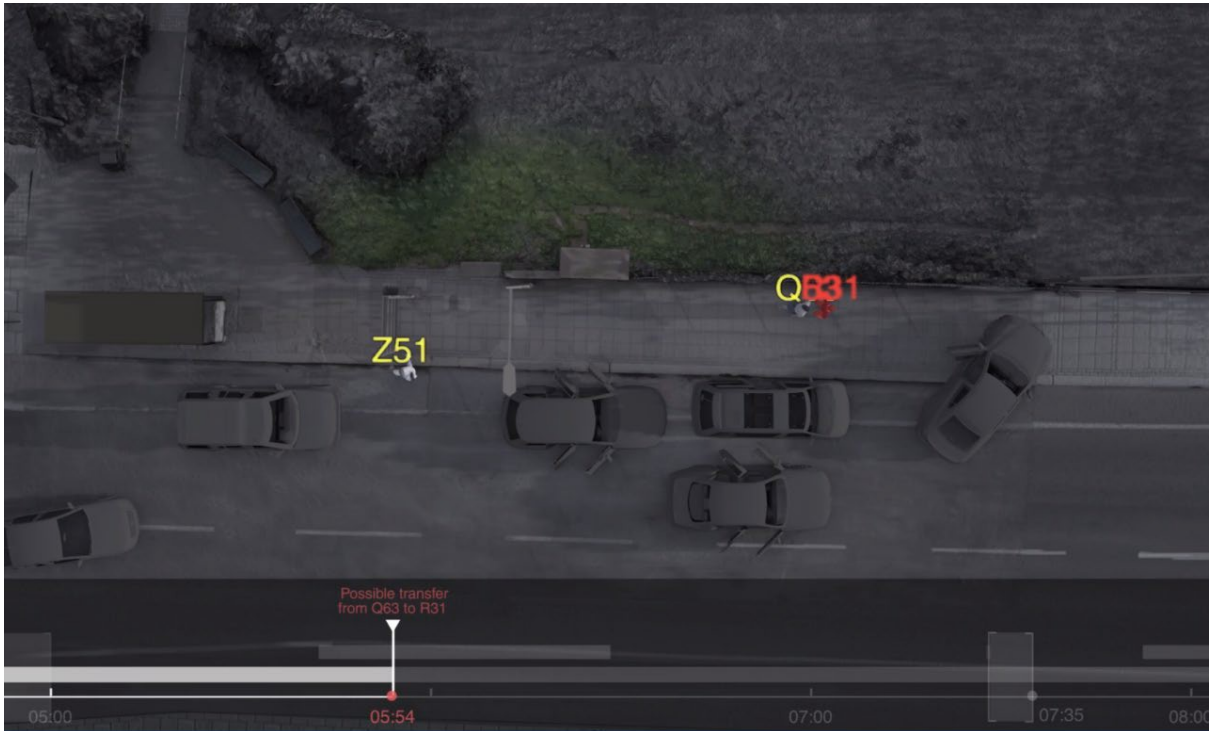


Fig. 44. A still from our animated sequence, based on the tracked Witness B footage. R31 and Q63 stand near to one another, around two minutes before the gun is found.

Around a minute earlier still, between 04m48s and 05m00s, Q63 disappears behind the minicab for around twelve seconds. Q63 was interrogated about his actions during this time while giving evidence to the inquest.⁸²



Fig. 45. 04m58s into the footage. Q63 is somewhere behind the minicab, not visible to Witness B's camera position.

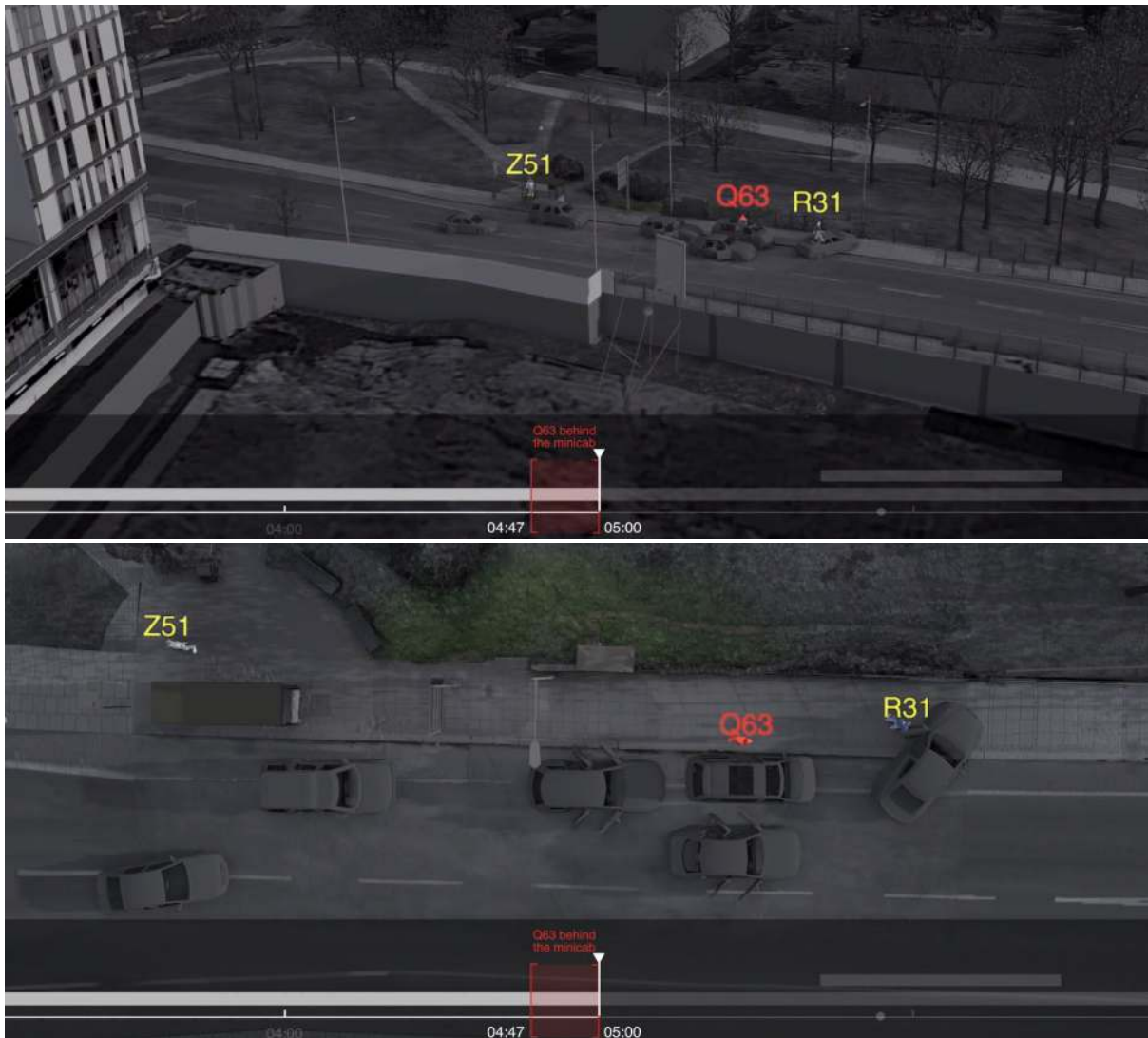


Fig. 46 and 47. 04m58s in our model. From Witness B's camera position (above), Q63 is out of sight behind the minicab. Given that Q63 is not visible to Witness B's camera, his position in the plan view (below) is hypothetical.

It is possible that during this twelve second period, Q63 retrieved the gun from the rear of the minicab. Indeed, this possibility was raised at the inquest.⁸³

To summarise, the following sequence of events is observable in the footage:

- Between 04m48s and 05m00s, Q63 is hidden from Witness B's camera position in the area behind the minicab and Charlie car.
- At 05m54s, Q63 and R31 stand together on the pavement, near the minicab.
- At 07m28s, Z51 gestures at a location on the grass, while R31 is approaching that location, having travelled from the pavement to the grass via the fence by Alpha vehicle at 06m05s.

This sequence of events, a possible route by which the gun could have been transported from the minicab to a location on the grass, is described by the following image.

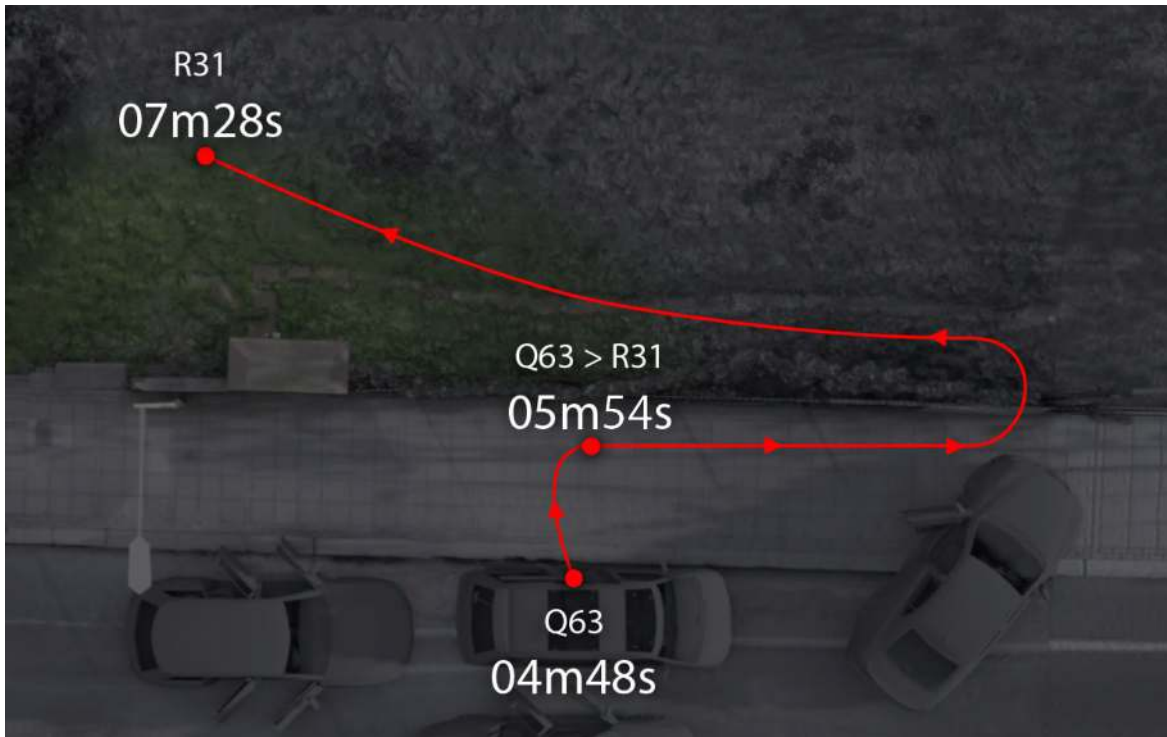


Fig. 48. According to our analysis of the movements of officers as visible in the footage, the gun could have travelled this route from the minicab to the location at which it was found.

According to our analysis, there is nothing in the available evidence to *exclude* the possibility that this sequence of events included Q63's acquiring the gun from the rear of the minicab, it being passed from Q63 to R31, and eventually deposited on the grass. Indeed, there is *precisely the same amount of evidence*, based on the footage, for the sequence of events described above as there is for the assertion that 'there is... no sign of any officer planting a firearm on the grass during the "BBC Footage"'.⁸⁴ We identified a number of such possible routes.

FINDING 5

The available evidence does not rule out the possibility that officers moved the gun to the location at which it was found, after Mr Duggan was shot.

Nothing in the available evidence provides any justification for this explanation for the gun's location to be considered less likely than any other. In fact, given that it does not require actions by Mr Duggan which are inconsistent with the evidence of Dr Bauer and Professor Pounder, this scenario is more consistent with the totality of available evidence than the account offered by V53, and taken up by the IPCC.

Failures of investigation relating to the ‘Witness B footage’

Several explanations could be offered for the IPCC’s incorrect interpretations of the video evidence, described above; in any case, it is true that the analysis of that evidence could have been carried out more effectively. Further, the capacity of the inquest to question witnesses would have been enhanced by more effective analysis of the available video evidence.

Limited scope of previous imagery analysis

Two reports on the footage were made by experts in imagery analysis: one, by David Thorne of Demux Video Services,⁸⁵ and one by Clive Burchett of LGC Forensics.⁸⁶

Thorne identifies a total of seven video clips in the ‘Witness B footage’ (referred to in his report by the name ‘GAJ/8/WC1’).⁸⁷ Mr Thorne’s analysis uses seconds as the smallest discrete unit of time, suggesting he did not carry out frame-by-frame analysis of the video evidence.⁸⁸ Had he done so, it is possible that he would have identified the ‘gap’ discussed at length below.

Mr Burchett’s report seems to corroborate that there were originally ‘seven (7) video clips saved as .VOB files’ passed to the IPCC.⁸⁹ However, Mr Burchett then refers to an ‘original six (6) .3gp files’.⁹⁰ This apparent discrepancy is not explicitly addressed or explained anywhere in Mr Burchett’s report, or in his evidence to the inquest.

Mr Burchett’s report includes a table listing the duration of each of the six original .3gp files.⁹¹ However, that table fails to identify a ‘gap’ in the footage at 08m37s. According to both our analysis and that of Mr Thorne, the next fragment of footage begins around 45 seconds later.⁹²

An unidentified ‘gap’

Note: *Since the subject of the analysis below is video material, it should be read in tandem with, and in constant reference to, the video clip available here: <https://tinyurl.com/s9nlq94>*

This gap is also discussed in detail in our full video investigation, and in the recording of our 30 November 2019 presentation, URLs for which can be found at the top of this report.

There is an additional gap in the footage at 05m02s, which Mr Thorne’s analysis misses entirely.⁹³ Mr Burchett acknowledges this gap, in the table referred to above, but fails to acknowledge or address that this gap is of a different quality to the others listed in the table.

The gap at 05m02s is unlike the others identified by Mr Thorne and Mr Burchett because the perspective and content of the frames immediately before and after it are very similar. By contrast, other gaps in the footage are discernible precisely because the position and direction of the camera changes tangibly. The following four images demonstrate these differences.



Fig. 49. The frames immediately before (left) and after (right) the 'gap' at 05m02s.



Fig. 50. The frames immediately before (left) and after (right) the 'gap' at 08m37s.

The similarity between the frames either side of the 05m02s gap suggest that only a short period of real-world time had elapsed between those frames.

The significance of the gap

The actions of a number of officers during period of time in which the 05m02s gap occurs was the subject of repeated scrutiny during the inquest.⁹⁴ Shortly before the gap, Q63 'disappears' behind the minicab for approximately twelve seconds (as referred to above). Two seconds after the 05m02s gap, Q63 clearly gestures in the direction of the grass, approximately toward the location at which the gun was later found.⁹⁵

Given the attention that was paid to this section of the footage, it is notable that the 05m02s gap was apparently never noticed either by those taking active part in the inquest process, or the imagery analysts commissioned to analyse the content and structure of the footage.



Fig. 51. A detail still from our analysis of the 05m02s gap. Q63 is highlighted in the frame immediately before (left) and after (right) the gap at 05m02s.

As the image above demonstrates, between the frames either side of the gap, Q63 appears to have crossed the 'blind spot' behind the minicab. Plausibly, then, the 05m02s gap constitutes another period during which Q63 could have accessed the rear of the minicab.

FINDING 6

Imagery analysts commissioned by the IPCC and inquest failed to identify or properly investigate an additional gap in Witness B's footage, which would have been of potential interest to both processes.

Q63's actions during the period in which he disappeared behind the minicab for approximately twelve seconds were repeatedly interrogated at the inquest. During the period of the 05m02s gap, Q63 was similarly behind the minicab, in the vicinity of the open rear nearside door of the vehicle, for four seconds or more.

The officer's actions during this time could plausibly have been subjected to similar scrutiny, had the gap been appropriately identified by the analysts at Demux Video Services and LGC Forensics.

What caused the gap?

The close similarity in the camera position either side of the 05m02s gap suggests that Witness B did not intentionally end one video clip and begin another very shortly afterward.

The footage was filmed on a Blackberry mobile phone.⁹⁶ Although the specific model is not known, tests with a Blackberry 'Torch 9800' (a model contemporary to 2011) demonstrate that if such a device receives a text message or is otherwise caused to display a 'notification' to the user while it is recording video, the device will essentially *pause* recording for the duration of the time the notification is displayed, only to continue recording video, and writing data to the same .3gp file, after the notification is dismissed. We believe that this is the most coherent explanation for the 05m02s gap.

Note: a video clip evidencing this effect can be viewed here: <https://tinyurl.com/ubgd242>



Fig. 52. An FA team member tests the 'notification' theory.

Estimating the duration of the gap

Since there is no other material that would allow us to verify the duration of the gap at 05m02s, our analysis determined the minimum duration of gap by reference to the position and movement of the officers on site.

Note: A clip analysing the gap's duration can be viewed here: <https://tinyurl.com/w4j7z xu>

In the frames before and after the gap, officer Z51 can be seen walking. We estimated his walking speed, as observed in the time immediately before and after the gap, to be 1.3m/s. Approximating a reasonable estimate of his path, our analysis determines that the duration of the 05m02s gap is at least 4 seconds.



Fig. 53. Stills from our analysis of the 05m02s gap. Z51 is highlighted in the frames immediately before (left) and after (right) the gap.



Fig. 54. Two plan view stills from our animated reconstruction of the 05m02s gap, showing Z51's location immediately before and after the gap.

Methodology

Model: site, scene, and incident

Digital models are a central component of FA's investigative practice; this case was no different [see [Investigative Framework](#)]. Theoretically, our models are composed of three layers: site, scene, and incident.

Our digital model of the real-world location of the incident (Ferry Lane, Tottenham) is constructed from a photogrammetric survey of the area conducted by members of FA on 8 March 2019 [see [Terminology](#)]. This survey consists of taking thousands of still images in a spatially sequential pattern. We then use Reality Capture [see [Software](#)] to arrange those thousands of images into a 3D 'point-cloud' model.



Fig. 55. A member of FA's team conducts a photographic survey of the Ferry Lane site.

The point-cloud model serves as a basis for an architectural model, constructed in Blender [see [Software](#)]. We refer to this layer of the model, which includes accurately-dimensioned reconstructions of urban infrastructure, street furniture, and vegetation, as the 'site'.

Our digital model of the real-world site of the incident (Ferry Lane, Tottenham) is constructed from a photogrammetric survey of the area conducted by members of FA on 8 March 2019. We refer to this layer of the model, which includes accurately-dimensioned reconstructions of urban infrastructure, street furniture, and vegetation, as the 'site'.

The site layer is subsequently populated by models of the objects (such as vehicles) that were present at the time of the event. These digital objects are constructed using architectural modelling techniques, and by close reference to the Witness B footage, aerial plans prepared by the MPS⁹⁷ and photographs taken at the time.⁹⁸ By assembling and cross-referencing these models in 3D space we can precisely corroborate the dimensions of the relevant objects, resulting in a highly accurate model. We refer to this layer of the model as the 'scene'. Since

some of those objects change location throughout the incident, the scene layer has several stages of arrangement.



Fig. 56. An aerial perspective from within our digital model. All three 'layers'—site, scene, and incident—are visible.

Within the scene layer, our investigation entails of establishing and modelling as closely as possible *what happened*: the positions, poses, movements, and actions of the individuals involved, at each stage of the event. We refer to this layer of the model as the 'incident'. We derive the composition of the incident layer from witness statements, transcripts of oral evidence, and other reports, as described throughout this report. [see, for example, '[Analysing witness statements and testimony](#)', '[Estimating the locations of V53 and W42](#)', and '[Mr Duggan's injuries and body position](#)'].

Analysing witness statements and testimony

Much of the available information about the sequence of events immediately preceding the shooting of Mr Duggan is contained in the accounts of the CO19 officers, either in the witness statements they gave to investigators or the evidence they subsequently gave to the inquest, as well as in the accounts of a handful of civilian witnesses, including the minicab driver.

In order to analyse these accounts, and to examine where they agreed, and where they diverged, we segmented the incident into nine narrative 'moments' (from *the moments before the hard stop* to *immediately after the second shot was fired*) and examined what was said in each account about each of those moments.

This work was carried out in a spreadsheet, in which every row constituted a separate account (e.g. *W70's witness statement of 7 August 2011*) and every column constituted a 'moment' (e.g. *Mr Duggan moves towards V53 and W70*).

Document Reference	Witness	Date	1_Lead up	2_1st shot	3_Facing towards WAZ	4_Movement towards V53/W/O	5_MD's body/hands position at the time V53/W/O	6_1st shot	7_2nd shot	8_Between shots	9_2nd shot	10_After 2nd shot
V53, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000												

Fig. 57. A screenshot of the spreadsheet in which we analysed the officers' accounts of the 'moments' immediately before and after the shooting. Coloured text indicates possible areas of agreement or divergence.

Within our digital model, we then recreated each of these accounts, 'moment' by 'moment', to create a 'spatial database' composed of dozens of digital environments. Each environment approximated what one witness recalled about one 'moment' during the period of the shots.



Fig. 58. One of the digital environments which constitute our 'spatial database'. On the left are extracts from statements or transcripts of oral evidence.

As we examined each account, the descriptions given of particular 'moments' would be noted within the appropriate cell. This analysis allowed us to identify a number of notable instances of agreement or divergence between accounts. For example, as described above, V53 is the only officer who recalls that Mr Duggan made a sharp, backward 'flinching movement' with his right shoulder, after the officer has fired the first shot.⁹⁹

Modelling Mr Duggan's body

In order to accurately recreate the body positions and movements of MD during the incident, we first created a model human body (using the MakeHuman software).

The model has a height of 178cm, matching the height of Mr Duggan as detailed in the pathology report of Dr Simon Maurice Poole.¹⁰⁰

The model was then 'rigged' [see [Terminology: Inverse Kinematics \(IK\) Rig](#)] in order that it could be finely adjusted to adopt the positions described by witness statements and using Mixamo and posed in Cinema 4D and Blender, according to the results of our analysis.

In Blender, using a process called 'texture painting', we applied the shape of the wounds sustained by Mr Duggan to the 3D model of his body. We positioned cameras to match the orientation of images of the wounds and then used texture painting to mark them taking into account their size, shape and position.

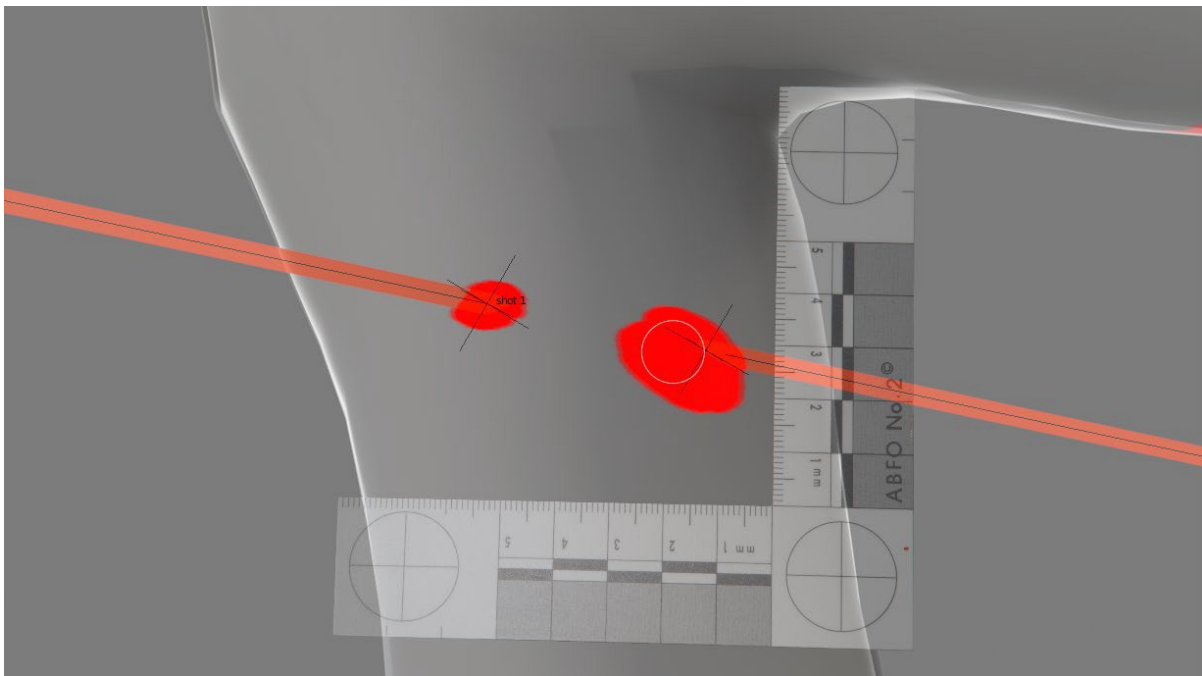


Fig. 59. Using a scaled image to paint wound markings onto the bicep of the model of Mark Duggan.

Lines drawn through these wounds gave us 'shot lines', which we could use to closely approximate Mr Duggan's body position at the time of the shots (see 'Entry and exit wounds').

Lines drawn through these wounds gave us 'shot lines', which described the path of the bullets through Mr Duggan's body.

Along with the heights and locations of V53 and W42, these shot lines created constraints for the spatial relationships between Mr Duggan, V53, W42, and the minicab, which informed our approximation of Mr Duggan's body position at the time of the shots [see [V53 and W42](#), '[Mr Duggan's injuries and body position](#)', and '[Locations Mr Duggan, V53, and W42](#)'].

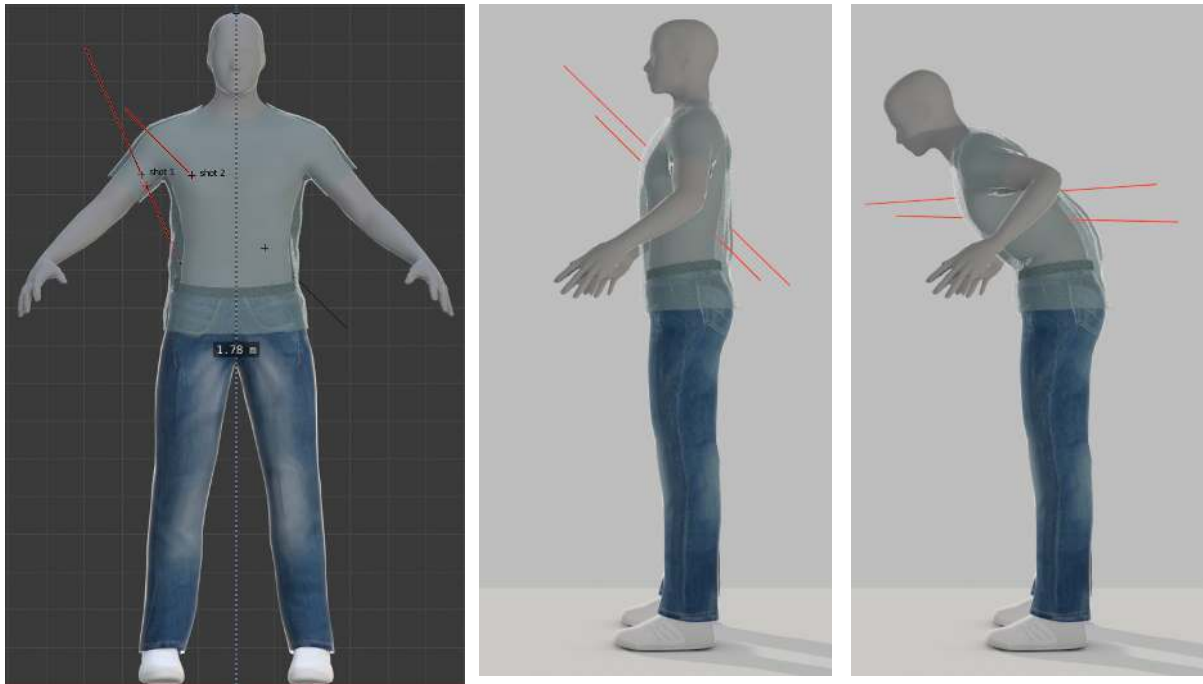


Fig. 60, 61, and 62. Our 3D model of Mr Duggan's body (left), and (centre; right) adjusting the modelled body according to the 'shot lines' and other constraints.

Modelling Mr Duggan's jacket

The process of modelling Mr Duggan's jacket was done in Marvellous Designer, Cinema4D, and Blender [see [Software](#)]. This helped us to approximate how the jacket would have moved as Mr Duggan moved, particularly during the period of the shots.

This was necessary because of the damage to the lower left corner pocket of Mr Duggan's jacket, and what this implied about the position of Mr Duggan's left arm at the time of V53's second shot [see [Damage to Mr Duggan's jacket](#)].



Fig. 63. Mr Duggan's jacket, modelled.

The process involved the creation of digital pattern, similar to the process of creating a real jacket, using photographs as a reference. These pattern pieces were then digitally 'stitched' together over the body of a 3D figure, and given properties of real fabric. The cloth simulation was then run on the animated figure in order to check whether the damage to the jacket was consistent with the likely movements of Mark Duggan during the shooting.

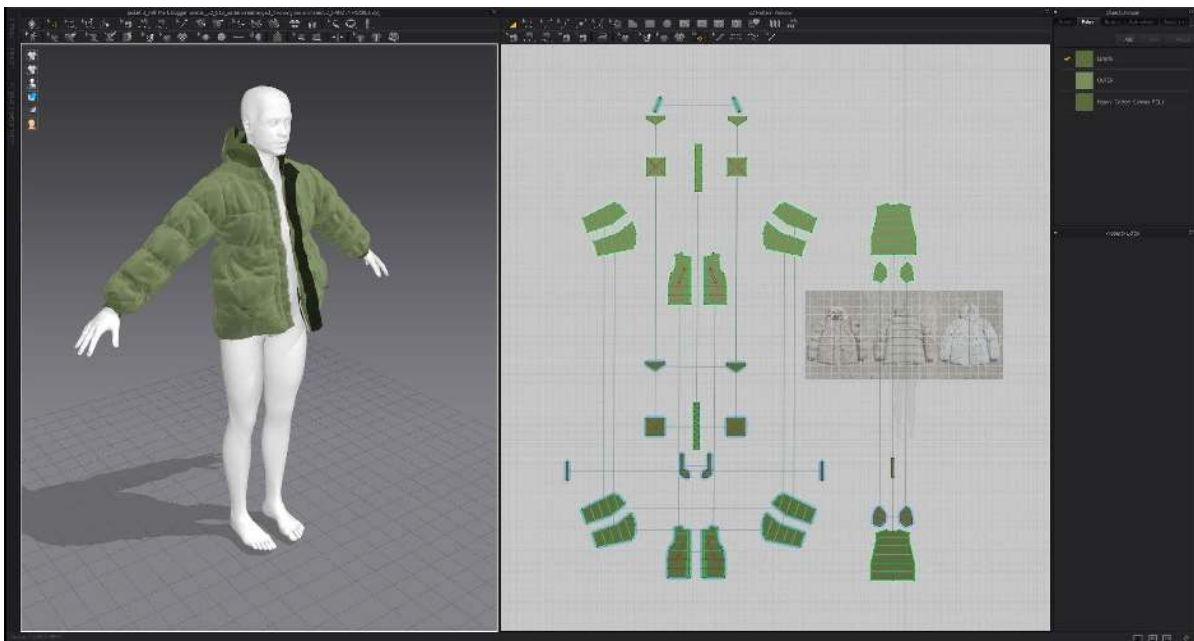


Fig. 64. 'Cuts' of digital fabric were 'stitched' together to create Mr Duggan's jacket.

Estimating the locations of V53 and W42

A number of the officers present at the incident drew plans to indicate where they thought W42 and V53 had been standing at the time of the shooting. Officers also mentioned the positions of W42 and V53 in their witness statements, and in evidence given before the inquest.

These plans and descriptions informed our positioning of W42 and V53 within the model.

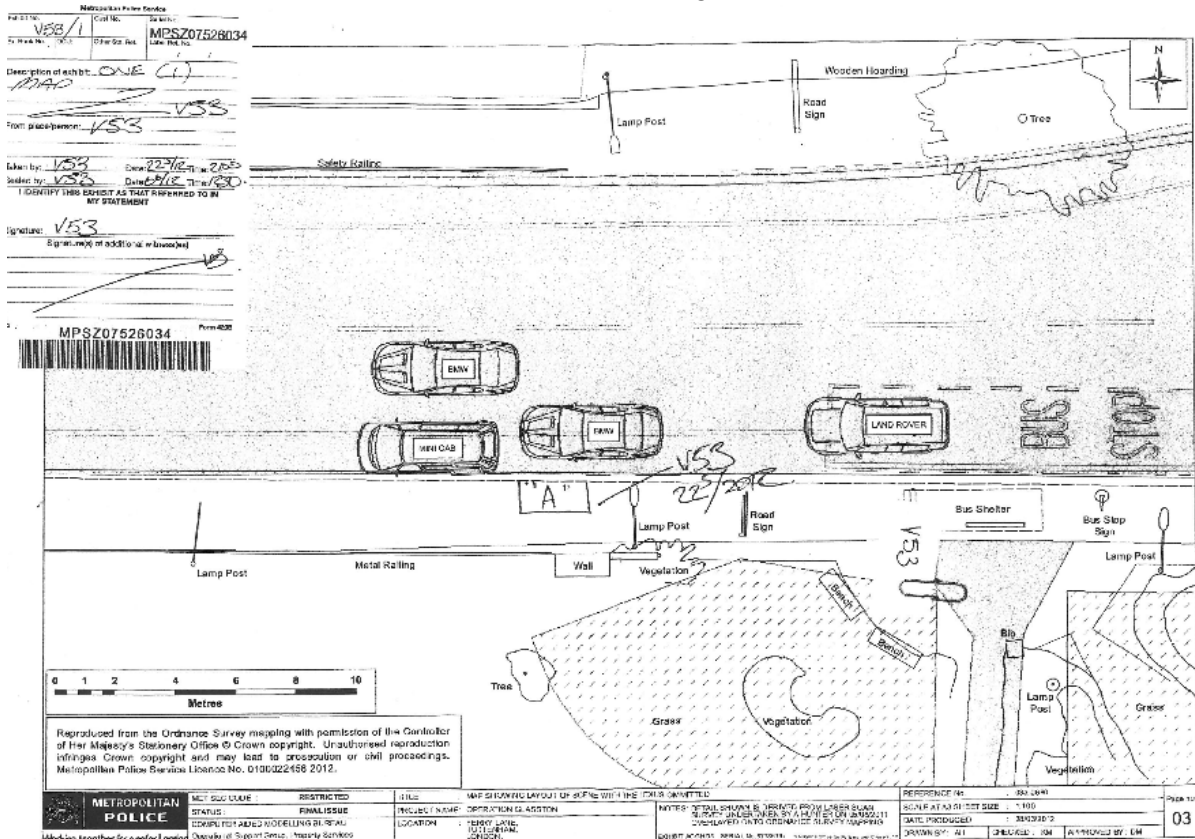


Fig. 65. Plan drawn by V53. The area 'A' indicates his estimated location at the time of the shooting.

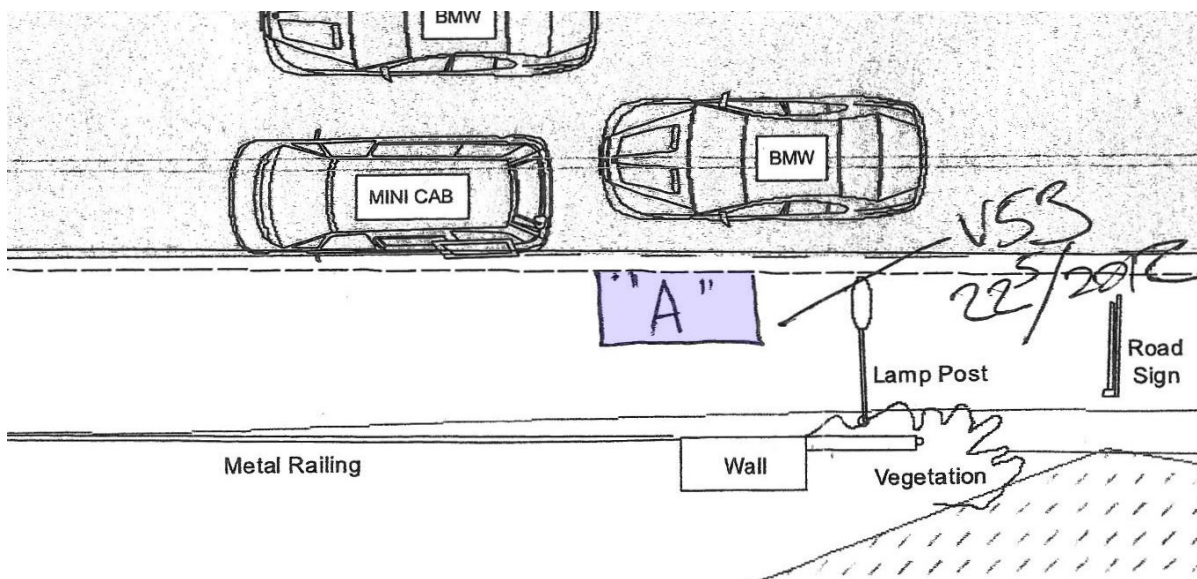


Fig. 66. Detail of the above plan; V53's indicated location has been highlighted blue.

We took each plan in turn and highlighted the areas estimated by that officer for the positions of V53 and W42.

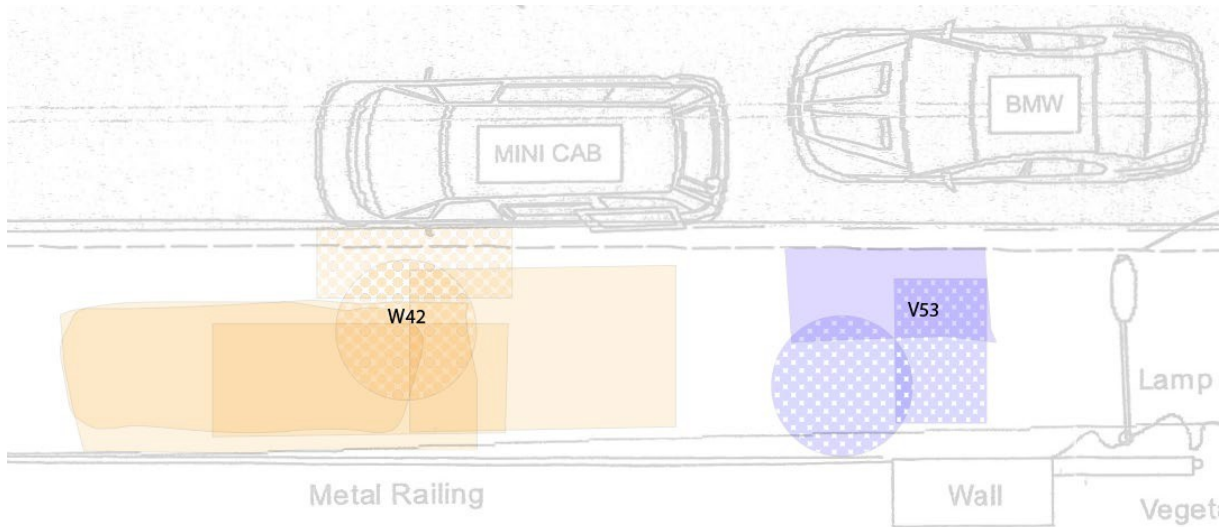


Fig. 67. A composite plan, in which every officers' estimation of the locations of W42 and V53 at the time of the shooting are superimposed.

In the image above, half-tone shading describes estimated locations derived from witness statements or evidence to the inquest. Full-tone shading indicates regions drawn directly onto the plan by officers. Darker areas indicate overlapping estimates.

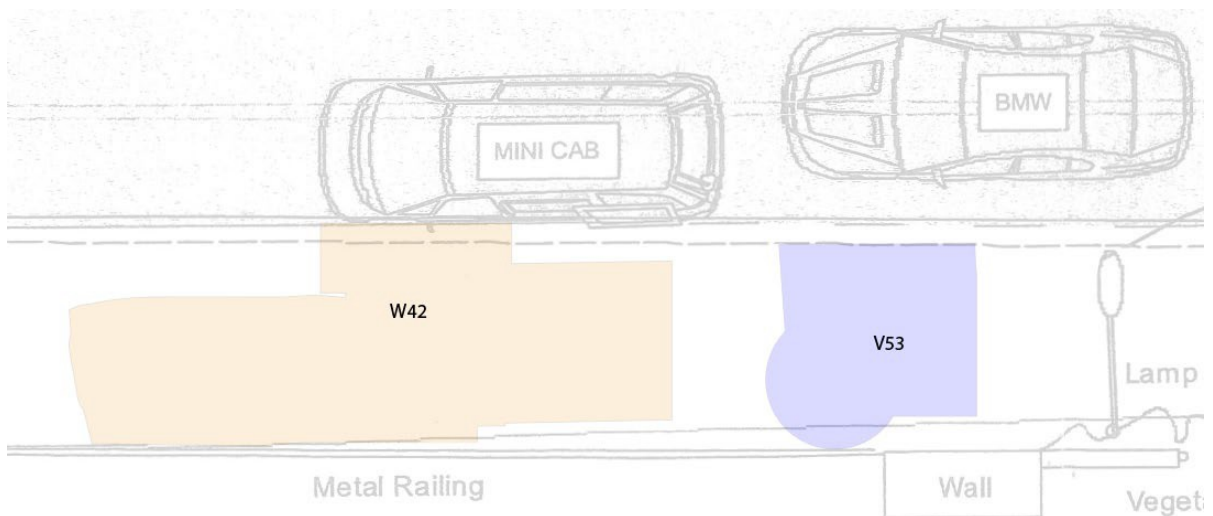


Fig. 68. The estimated locations of W42 and V53, merged.

We combined the regions indicated by the testimonies. Then, analysis of witness statements and reference to the evidence given by each officer to the inquest excludes some of the regions indicated on the plans.

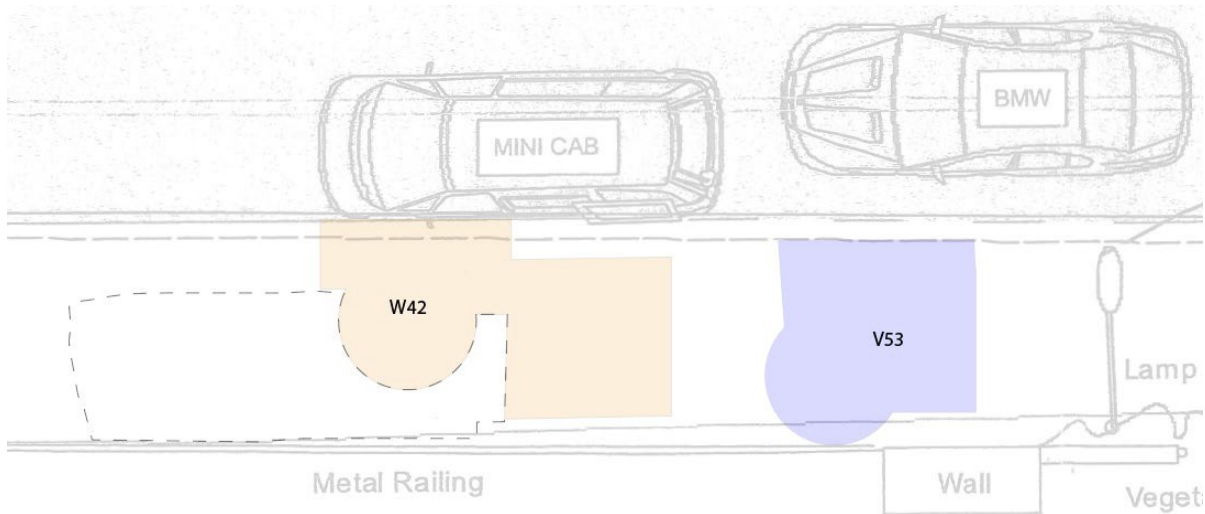


Fig. 69. Irrelevant regions are removed from the combined areas. On cross-reference with R31's oral transcript of evidence, this area refers to W42's location after he has been shot.

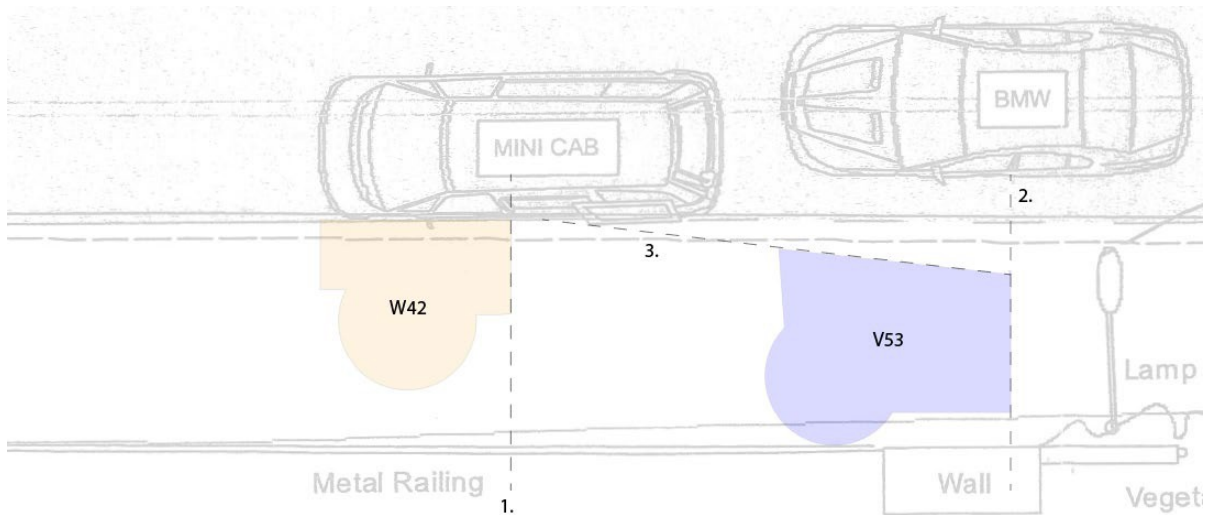


Fig. 70. Three additional constraints are added to the plan.

We narrow down the estimated locations of V53 and W42 by reference to three additional constraints:

1. W42 had not advanced further in the direction of Charlie car than the pillar between the nearside doors of the minicab.¹⁰¹
2. V53 was at least as advanced in the direction of the minicab as the pillar between the nearside doors of Charlie car.¹⁰²
3. At the time of the second shot, V53 was stood in such a position that the bullet could pass through Mr Duggan's body and enter the minicab through the open rear nearside door.¹⁰³

Motion capture

To inform our understanding of how Mr Duggan could have moved during his exit from the minicab, and to advance our investigation of the possibility that the gun was thrown from the threshold of the minicab [see [Scenario 2: Mr Duggan threw the gun before the period of the shots](#)], we staged a series of experiments in a motion capture studio, using OptiTrack¹⁰⁴ equipment. In the images below, a table and a chair approximate the height of the rear passenger seats and the footwell of the minicab. The location of Mr Duggan's footsteps according to Professor Pounder's 2019 report are marked with tape.

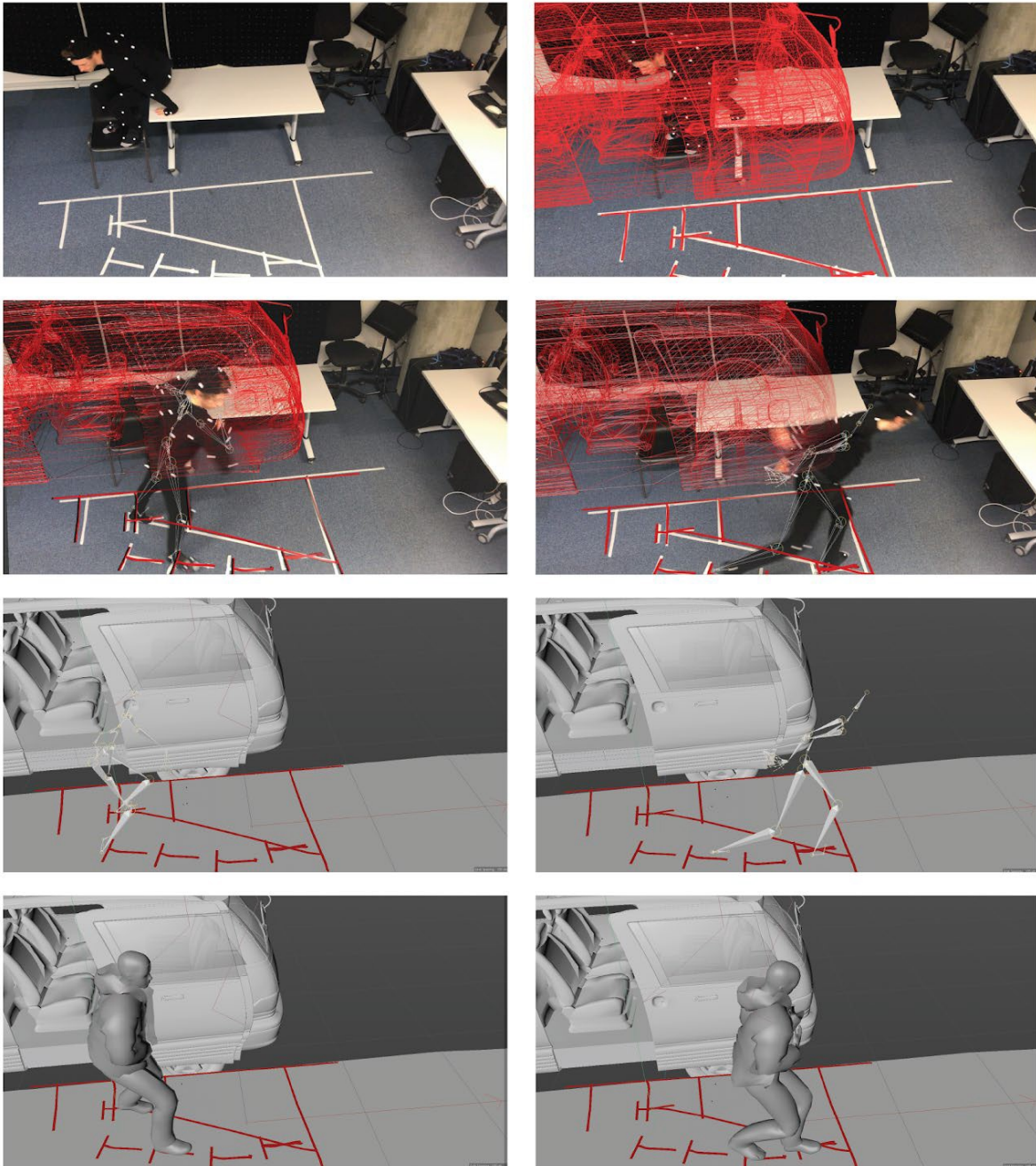


Fig. 71. The image pairs above illustrate (from top to bottom): the relationship between the dimensions of the studio set-up and the scene; linking points on the motion capture suit with joints on the 3D skeleton; the integration of the skeleton in the 3D scene; and the attachment of a modelled body to the rigged skeleton.

Adjusting timings from the CO19 training video

To simulate the possible movement and fields of vision of the officers during the real-life 'hard stop' on 4 August 2011, we referred to, and modelled, the 'hard stop' as seen in the CO19 training video [see [CO19 training video](#)].



Figs. 72 and 73. Side-by-side stills from the CO19 training video and our animated reconstruction, at two moments during the 'hard stop'.

As should be expected, the precise spatial arrangement of vehicles during the 'hard stop' that led to Mr Duggan's death varied from that of the training video. The image below displays (in our site model) the difference in the final positions of the vehicles in the CO19 training video (left) and the 'hard stop' in Ferry Lane (right).

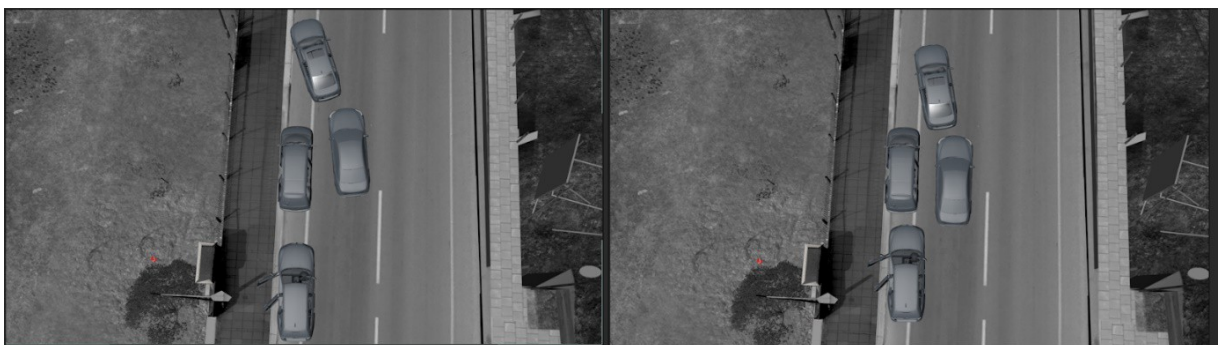


Fig. 74. Side-by-side aerial views comparing the positions of the vehicles following the training 'hard stop' (left) and on Ferry Lane (right).

Accordingly, we made adjustments to the timings, locations, and pacing of the vehicles and officers in our site model, taking the training video as a baseline, and taking account of elements of those officers' accounts of the 'hard stop' [see [Officers' perspectives](#)]. Some of the central examples of those elements follow:

- V53's evidence was that as he was exiting Charlie vehicle, W42 was already on the pavement, and that when Mr Duggan's 'feet hit the pavement', V53 was 'in the process' of exiting Charlie vehicle.¹⁰⁵
- W42's evidence was also that he was the first officer to have 'feet on the ground',¹⁰⁶ and that as he arrived at the nearside of the minicab, Mr Duggan was at the 'threshold' of the rear nearside door, in the process of exiting the minicab.¹⁰⁷
- W56's evidence was that as he arrived at the front offside window of the minicab, the driver's head was already turned to the left.¹⁰⁸
- The minicab driver's evidence suggests that the minicab was stationary before Mr Duggan opened the rear nearside door,¹⁰⁹ and that at least some officers had exited their vehicles by the time he heard his door open and looked backward over his left shoulder,¹¹⁰ at which time Mr Duggan was already 'going out of the door'.¹¹¹

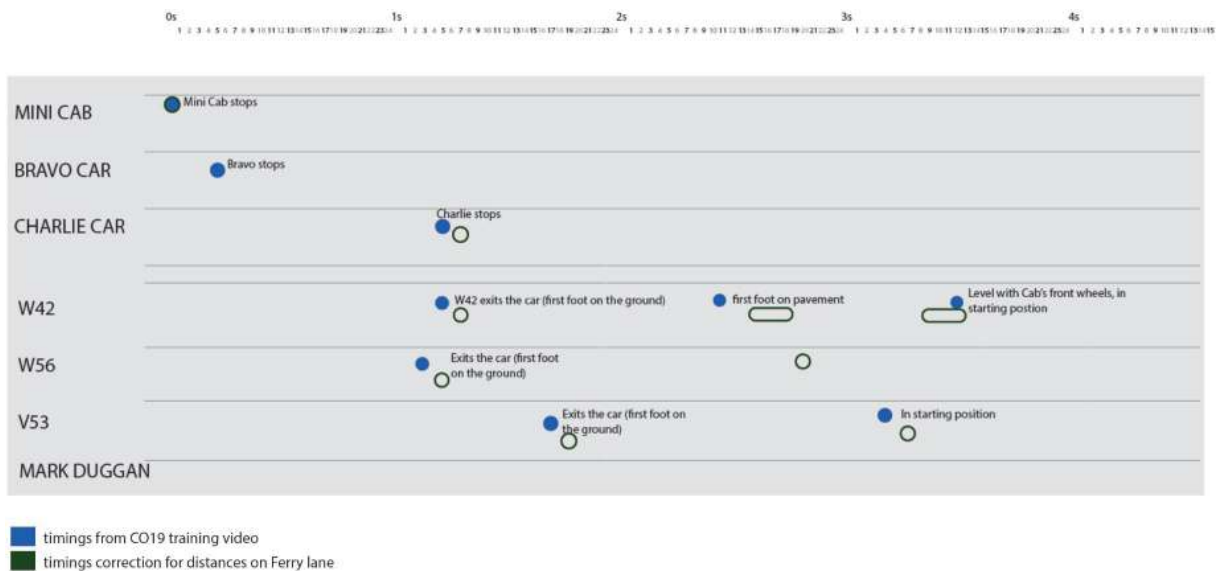


Fig. X. A frame-by-frame timeline of the period of the 'hard stop'. In blue, the timings as seen in the CO19 training video; in green, the timings corrected for differences between the training video and the Ferry Lane 'hard stop'.

Analysing the 'Witness B footage'

Stabilisation and tracking

First, we stabilised the footage using a process of 'motion tracking'. Technically, this required Cinema4D's motion-tracking features, as well as both automatic and manual tracking in Adobe After Effects [see [Motion Tracking](#)].

Note: A short video clip demonstrating the result of this process of stabilisation can be seen here: <https://tinyurl.com/ubl755v>

With the footage stabilised, we were better able to track the moving figures around the scene. First, we gave every visible individual a generic codename, and wherever we were able to confirm their identity based on witness statements, oral evidence, or other information, we tagged them with their CO19 codename. For example, Q63 was wearing a white t-shirt, and was therefore easily identifiable.¹¹²



Fig. 75. Officers are identified and 'tracked' in the footage.

'Projecting' the footage onto a 3D model

We 'mapped' the movement of the officers in 3D space by 'projecting' the footage onto our site model from Witness B's camera position.

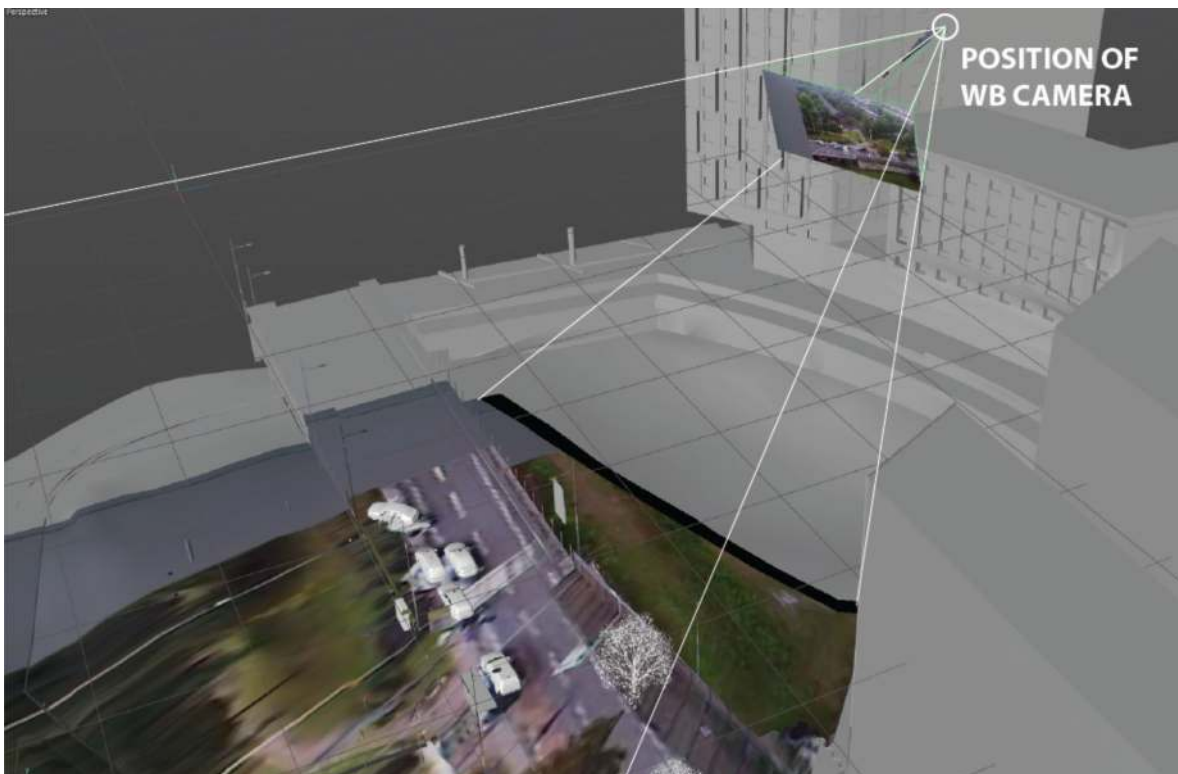
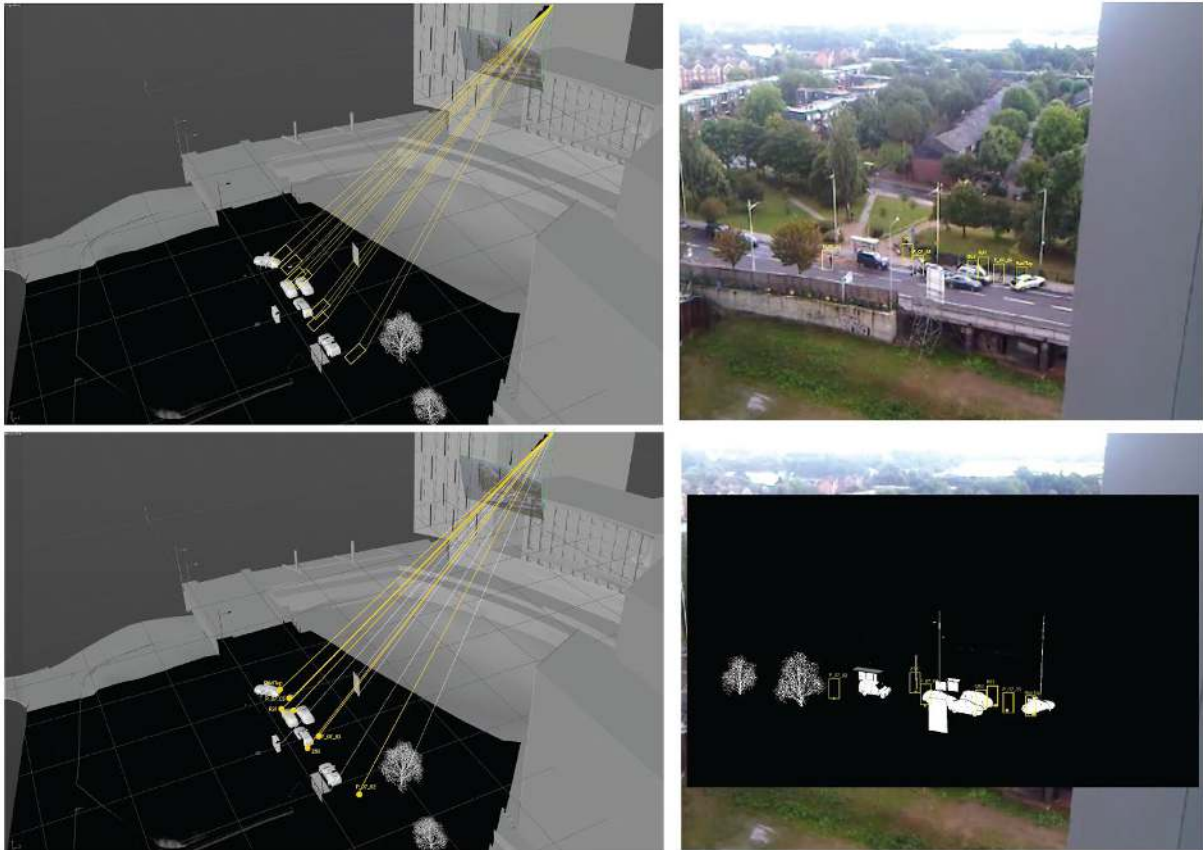


Fig. 76. Within our digital model, Witness B's footage is 'projected' from his camera position.

In addition to matching the projected footage to aspects of our site and scene models [see [Model: site, scene, incident](#)], we further visually related the observed movements of the officers with other features of the site, such as vehicles and street furniture. This made the process more accurate, and mitigated for the challenges posed by the poor quality of the footage, particularly its low pixel resolution, particularities of image compression and lack of 'anti-aliasing'.¹¹³



Figs. 77 and 78. After estimating the officers' position using 'footage projection' (above), we check and improve those estimates against the known locations of elements of our site and scene models (below).

'Blind spots'

In addition to certain characteristics of the footage which made the process of tracking the officers more challenging [see '[Projecting the footage onto the 3D model](#)'], certain locations around the site are simply obscured from view, from Witness B's camera position. The process of footage projection makes these 'blind spots' clearly visible, as if they were 'shadows' cast by a light source situated at Witness B's camera position.



Fig. 79. An aerial view of the 'blind spots' in the footage. 'Shadows' cast by different objects are given a different identifying colour.

We combined all this information to produce a plan-view animation which mapped the approximated position of every officer, from the beginning of the footage to the moment at which the gun was reportedly found.



Fig. 80. Screenshot from our split-screen animation showing the stabilised footage with markers (left) and the translation of the information into a 2d top-view animation (right)

We translated the resulting information into a timeline, which described when every individual visible in the footage moved into, and out of sight from Witness B's camera position [see [Timeline](#)].

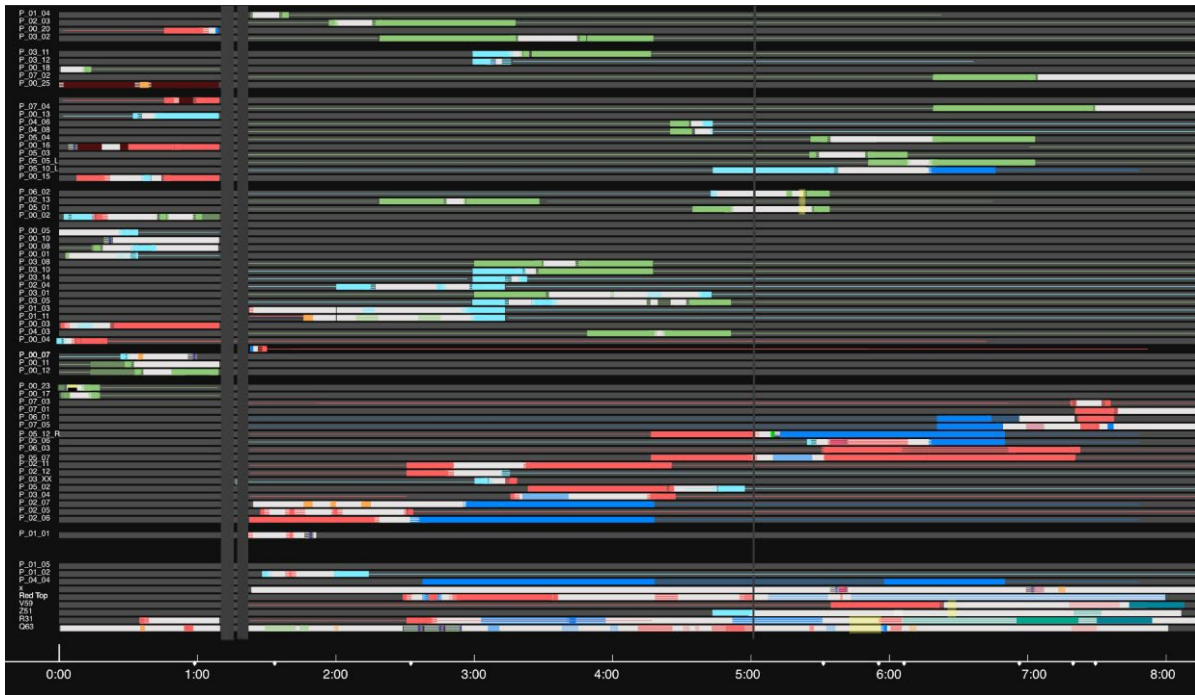


Fig. 81. This timeline describes the movement of every individual visible in Witness B's footage, and where those individuals move into 'blind spots' which hide them from Witness B's camera position.

Whenever an officer is visible, they appear on the timeline as a white bar. Whenever they enter a 'blind spot', their 'track changes colour to that of the blind spot. Whenever there is no information about the position of the figure, the track is dark grey.

Note: this timeline can be viewed in full here: <https://tinyurl.com/tym3hw6>

We used the timeline to organise our research as we attempted to narrow down and identify certain officers, and match their actions to their testimony, as well as to identify possible scenarios by which the gun could have been transferred between officers and transported toward the location at which it was later found [see Scenario 3: Officers moved the gun after Mr Duggan had been shot].

One more such scenario is highlighted in red in the image below, and detailed here:

- G1. 00m55s: the gun is taken out of the cab by Q63
- G2. 02m19s: Q63 hands the gun over to P_02_07
- G3. 02m25s: Unidentified individual P_02_07 leaves the gun in Alpha vehicle
- G4. 03m02s-03m09s: Q63 opens the door to Alpha vehicle and collects the gun
- G5. Q63 passes the gun to R31 during interaction by Alpha vehicle at 05m30s
- G6. 06m15s-07m40s: At some point following the point marked 'G-end', R31 leaves the gun at the location at which it was reportedly found.

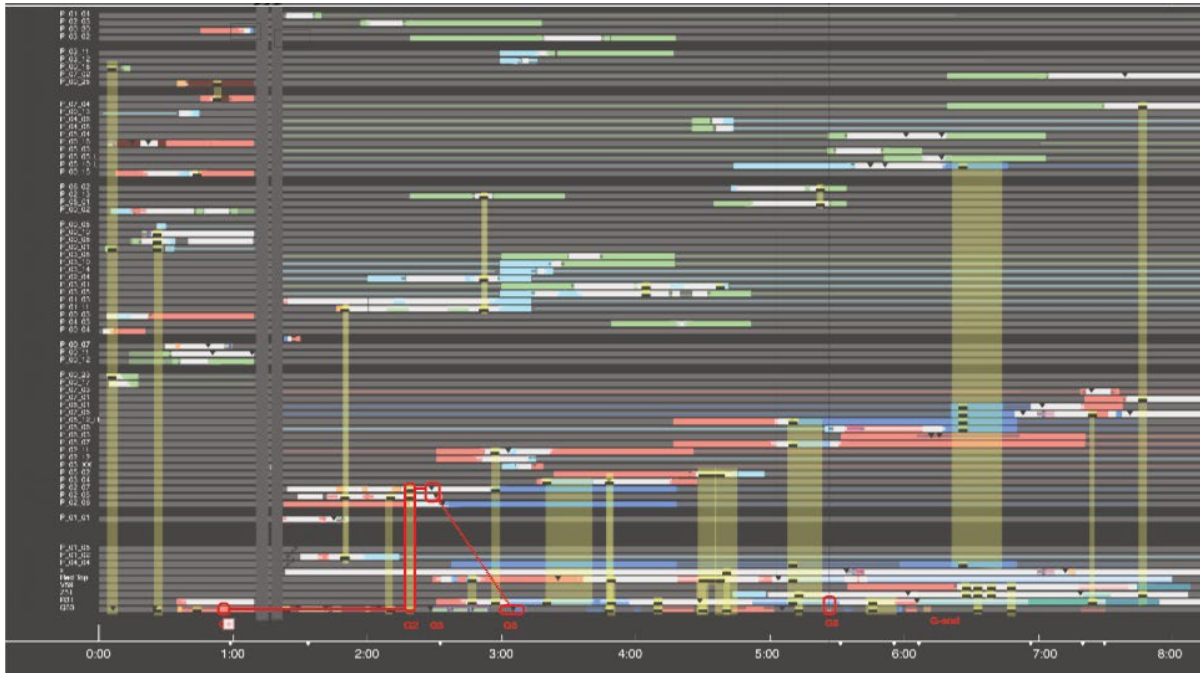


Fig. 82. One of the possible scenarios we identified (referred to as Scenario 'G') is highlighted on the timeline in red. Interactions between officers are indicated with yellow bars.

Through close examination of the footage, we identified over 30 similarly possible scenarios by which the gun could have been moved from the minicab to the location at which it was later found. It is likely that more could be identified.

Virtual Reality

We have also prepared our incident model to be experienced in virtual reality (VR), as a means of experiencing the moments during which Mr Duggan was shot, and of trialling some of the scenarios detailed in this report.

When viewing a 3D scene, a 'fixed frame', such as a monitor screen, will always be a limited approximation of vision. With VR, by contrast, a user can move their visual attention around a scene in a fashion which more closely approximates human vision. Given that many of the open questions around this case are questions of visual attention and peripheral perception, we considered that VR could be a valuable analytic tool, and indeed proposed its use in the civil claim in the context of which we were commissioned.

Human vision has a wide 'field of vision', which spans about 150 degrees horizontally and 120° vertically. But our sensitivity to changes within that field of vision is not homogenous: only about 5° of the visual field—the area the eye is looking directly toward—is sufficiently sensitive for demanding visual-perceptual tasks, whereas marginal areas of the visual field are particularly sensitive for low light intensities and movements.¹¹⁴

Terminology

Photogrammetry

Photogrammetry is a process for deriving real-world measurements from photographic data. The process can be used to generate very detailed and spatially accurate 3D models of real spaces.

Rigging

The process of applying a bone structure to a 3D model which facilitates the positioning and deformation of limbs. A 'rig' is the result of the rigging process, and is made of 'bones'.

Inverse Kinematics (IK) Rig

A 'rig' in which the 'bones' are connected by a method known as 'inverse kinematics'. This method takes the movement of the 'endpoint' of a bone structure (such as a hand or foot) and updates the movement and location of other bones in the chain accordingly.

Armature

A bone structure used to deform a 3D model. It is a component of the rigging process.

Custom armature constraints

Constraining the movement of a bone or bones in an armature in order to restrict or extend their range of movement.

Texture painting

'Texture painting' is the process of applying illustrative or graphic detail onto the surface of a 3D model.

Point-cloud

An array of 'points'—coordinates in 3D space—which together constitute a render of an architectural space.

Synchronisation

The process of synchronising different pieces of video or audio material allows us to accurately sequence complex events.

Software

Cinema4D¹¹⁵

Proprietary 3D modelling and animation software for staging, motion, texturing, and deforming 3D objects in time and space. In particular, we were able to utilise the take system as a procedural tool for representing testimony.

Blender¹¹⁶

Open source 3D modelling and animation software for staging, motion, texturing, and deformation of 3D objects in time and space. In particular, we were able to utilise custom armature constraints for Mr Duggan's body position.

MakeHuman¹¹⁷

Open source 3D character-modelling software. It enables the creation of human figures according to parametric inputs such as height and body proportion.

Mixamo¹¹⁸

Proprietary 3D character-rigging and animation software. Allows the uploading of a 3D model so that it can be 'rigged'.

Reality Capture

Photogrammetry software. We use Reality Capture to create a 'point-cloud' and 3D model of the site based on a photogrammetric survey.

Marvellous Designer

3D clothing designer and simulation software.

References

- ¹ More on FA's use of models can be found in Weizman, Eyal (2017), *Forensic Architecture: Violence at the Threshold of Detectability*, New York (Zone Books)
- ² David Charles Thorne – Independent Imagery Analyst Tables, 20.09.12, p2
- ³ Clive Richard Burchett – Imagery Analysis Report, 27.10.13, p10
- ⁴ URL: [https://webarchive.nationalarchives.gov.uk/.../Jurys_Determination_and_Conclusion\(1\).pdf](https://webarchive.nationalarchives.gov.uk/.../Jurys_Determination_and_Conclusion(1).pdf)
- ⁵ URL: <https://www.statewatch.org/news/2015/mar/uk-IPCC-investigation-report-fatal-shooting-of-MD.pdf>
- ⁶ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: Finding 24, p485
- ⁷ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: Finding 19, p468
- ⁸ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: Finding 21, p475
- ⁹ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011, p7
- ¹⁰ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: Finding 16, p463
- ¹¹ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: Finding 9, p443
- ¹² IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: Finding 22, p479
- ¹³ Dr Simon Maurice Poole, statements 06-07.03.12, p3
- ¹⁴ Dr Simon Maurice Poole, statements 06-07.03.12
- ¹⁵ Prof Derrick Pounder, Reports 05.07.13 and 02.09.13
- ¹⁶ Dr Simon Maurice Poole, statements 06-07.03.12, p6
- ¹⁷ Forensic Science Service, Examination Record (Jacket), 11.08.11
- ¹⁸ Forensic Science Service, Examination Record (Jacket), 11.08.11
- ¹⁹ Inquest, transcript of evidence, V53, 15.10.13, p42; Inquest, transcript of evidence, W70, 23.10.15, p10
- ²⁰ Inquest, transcript of evidence, W42, 23.10.13, p151
- ²¹ Statement, Philip John Seaman, 29.08.13, p11
- ²² Inquest, transcript of evidence, V53, 15.10.13, p58
- ²³ Inquest, transcript of evidence, W42, 24.10.13, p104
- ²⁴ Inquest, transcript of evidence, W42, 24.10.13
- ²⁵ Prof Derrick Pounder, Report on the Death of Mark Duggan, 22.06.19
- ²⁶ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: Finding 19, p468
- ²⁷ Prof Derrick Pounder, Reports 05.07.13 and 02.09.13, p5
- ²⁸ Inquest, transcript of evidence, V53, 15.10.13, p49
- ²⁹ Inquest, transcript of evidence, W42, 24.10.13, p94
- ³⁰ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: paragraph 1640-45, p472-3
- ³¹ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: paragraph 1642, p472
- ³² Prof Derrick Pounder, Reports 05.07.13 and 02.09.13, p6
- ³³ Inquest, transcript of evidence, V53, 15.10.13, p51
- ³⁴ For example: Inquest, transcript of evidence, W70, p13, p74, p76; Inquest, transcript of evidence, W39, p13
- ³⁵ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: Finding 24, p485
- ³⁶ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: paragraph 1705, p489
- ³⁷ Prof Derrick Pounder, Report on the Death of Mark Duggan, 22.06.19
- ³⁸ Prof Derrick Pounder, Report on the Death of Mark Duggan, 22.06.19
- ³⁹ Prof Derrick Pounder, Report on the Death of Mark Duggan, 22.06.19
- ⁴⁰ Dr Jeremy J. Bauer, Report on the Death of Mr Duggan, p13
- ⁴¹ It should be noted that this distance is greater than the figure of 4.35m, referred to multiple times in the IPCC report, including at p479, which is the distance from Mr Duggan's body as it was positioned during the laser scan survey conducted at the scene.
- ⁴² Dr Jeremy J. Bauer, Report on the Death of Mr Duggan, p10
- ⁴³ Dr Jeremy J. Bauer, Report on the Death of Mr Duggan, p14
- ⁴⁴ Dr Jeremy J. Bauer, Report on the Death of Mr Duggan, p14
- ⁴⁵ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: Finding 24, p485
- ⁴⁶ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: paragraphs 1652-1658, p475-8
- ⁴⁷ URL: <http://suncalc.net/#/51.5879,-0.0577,17/2011.08.04.18:10>
- ⁴⁸ Inquest, transcript of evidence, V53, 15.10.13, p45
- ⁴⁹ Inquest, transcript of evidence, V53, 15.10.13, p46
- ⁵⁰ Inquest, transcript of evidence, V53, 15.10.13, p168
- ⁵¹ For example, Prof Derrick Pounder, Report on the Death of Mark Duggan, 22.06.19, p14-16
- ⁵² Prof Derrick Pounder, Report on the Death of Mark Duggan, 22.06.19, p19
- ⁵³ Dr Jeremy J. Bauer, Report on the Death of Mr Duggan
- ⁵⁴ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: paragraph 1693, p487
- ⁵⁵ Prof Derrick Pounder, Report on the Death of Mark Duggan, 22.06.19, p19
- ⁵⁶ Dr Jeremy J. Bauer, Report on the Death of Mr Duggan, p16
- ⁵⁷ Dr Jeremy J. Bauer, Report on the Death of Mr Duggan, p16
- ⁵⁸ Inquest, transcript of evidence, W42, 24.10.13, p66
- ⁵⁹ Inquest, transcript of evidence, 06.11.13 and elsewhere
- ⁶⁰ For example: Inquest, transcript of evidence, V48, 22.10.13, p50
- ⁶¹ Inquest, transcript of evidence, W42, 24.10.13, p66
- ⁶² Inquest, transcript of evidence, W42, 24.10.13, p67
- ⁶³ Inquest, transcript of evidence, W42, 24.10.13, p65

- ⁶⁴ Inquest, transcript of evidence, W42, 23.10.13, p144
- ⁶⁵ Inquest, transcript of evidence, W56, 24.10.13, p113
- ⁶⁶ Inquest, transcript of evidence, W56, 24.10.13, p121
- ⁶⁷ Inquest, transcript of evidence, W56, 24.10.13, p121
- ⁶⁸ Inquest, transcript of evidence, V53, 15.10.13, p14
- ⁶⁹ Inquest, transcript of evidence, V53, 15.10.13, p42
- ⁷⁰ <https://www.bbc.co.uk/news/uk-17859958>
- ⁷¹ Clive Richard Burchett – Imagery Analysis Report, 27.10.13
- ⁷² IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: paragraph 1673, p481
- ⁷³ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: paragraph 11, p10; 'Responses to specific questions raised by Mr Duggan's family', p492. Findings 22-24 (pg 479-492) also do not address the possibility.
- ⁷⁴ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: paragraph 1676, p482
- ⁷⁵ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: paragraph 1706, p489
- ⁷⁶ Inquest, transcript of evidence, Mr Clive Burchett, 30.10.13, p14
- ⁷⁷ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: paragraph 1706, p489
- ⁷⁸ Clive Richard Burchett – Imagery Analysis Report, 27.10.13, p22; Inquest, transcript of evidence, Z51, 2.10.13, p32
- ⁷⁹ Most straightforwardly, for example, Q63's white shirt, and his actions as described in the transcript of his oral evidence, render him readily and consistently identifiable.
- ⁸⁰ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: paragraph 1706, p489
- ⁸¹ Clive Richard Burchett – Imagery Analysis Report, 27.10.13, p22; Inquest, transcript of evidence, Z51, 2.10.13, p32
- ⁸² Inquest, transcript of evidence, Q63, 09.10.13
- ⁸³ Inquest, transcript of evidence, V59, 09.10.13, p6
- ⁸⁴ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: paragraph 1706, p489
- ⁸⁵ David Charles Thorne – Independent Imagery Analyst Tables, 20.08.12; David Charles Thorne – Independent Imagery Analyst Statement, 20.08.12
- ⁸⁶ Clive Richard Burchett – Imagery Analysis Report, 27.10.13
- ⁸⁷ David Charles Thorne – Independent Imagery Analyst Statement, 20.08.12, p7-9
- ⁸⁸ David Charles Thorne – Independent Imagery Analyst Tables, 20.08.12
- ⁸⁹ Clive Richard Burchett – Imagery Analysis Report, 27.10.13, p10
- ⁹⁰ Clive Richard Burchett – Imagery Analysis Report, 27.10.13, p10
- ⁹¹ Clive Richard Burchett – Imagery Analysis Report, 27.10.13, p10
- ⁹² David Charles Thorne – Independent Imagery Analyst Tables, 20.08.12, p16
- ⁹³ David Charles Thorne – Independent Imagery Analyst Tables, 20.08.12, p11
- ⁹⁴ For example: Z51 transcript of evidence 2.10.13, p153; V59 transcript of evidence 9.10.13, p63-4; Inquest, transcript of evidence, Q63, 9.10.13, p169
- ⁹⁵ Inquest, transcript of evidence, Q63, 9.10.13, p171
- ⁹⁶ Clive Richard Burchett – Imagery Analysis Report, 27.10.13, p10
- ⁹⁷ MPS, Map Showing Layout of Vehicles and Identified Objects on Ordnance Survey Master Map, 01b-0680, 28.03.12
- ⁹⁸ For example: Inquest, Photograph CE 0080, 15.10.13
- ⁹⁹ Inquest, transcript of evidence, V53, 15.10.13, p51
- ¹⁰⁰ Dr Simon Maurice Poole, statements 06-07.03.12
- ¹⁰¹ Inquest, transcript of evidence, W42, 24.10.13, p64
- ¹⁰² Inquest, transcript of evidence, V53, 15.10.13
- ¹⁰³ IPCC, The fatal police shooting of Mr Duggan on 4 August 2011: Finding 20, p473
- ¹⁰⁴ URL: <https://www.optitrack.com/>
- ¹⁰⁵ Inquest, transcript of evidence, V53, 15.10.13, p134
- ¹⁰⁶ Inquest, transcript of evidence, W42, 23.10.13, p143
- ¹⁰⁷ Inquest, transcript of evidence, W42, 23.10.13, p147
- ¹⁰⁸ Inquest, transcript of evidence, W56, 24.10.13, p121
- ¹⁰⁹ Inquest, transcript of evidence, minicab driver, 14.10.13, p42
- ¹¹⁰ Inquest, transcript of evidence, minicab driver, 14.10.13, p14
- ¹¹¹ Inquest, transcript of evidence, minicab driver, 14.10.13, p30
- ¹¹² Inquest, transcript of evidence, Q63, 10.10.13, p22
- ¹¹³ Anti-aliasing is the process of smoothing out jagged 'edges' in digital images by averaging the colour values between two pixels at their boundary.
- ¹¹⁴ Stephen Pheasant, Workspace Design: Anthropometry, Ergonomics and the Design of Work (1996)
- ¹¹⁵ <https://www.maxon.net/en/products/cinema-4d/overview/>
- ¹¹⁶ <https://www.blender.org/>
- ¹¹⁷ <http://www.makehumancommunity.org/>
- ¹¹⁸ <https://www.mixamo.com/>